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**WHAT PEOPLE COMPLAIN ABOUT DRONE APPS?  
A LARGE-SCALE EMPIRICAL STUDY OF GOOGLE PLAY STORE REVIEWS**

A thesis submitted to  
the Graduate College of  
Marshall University  
In partial fulfillment of  
the requirements for the degree of  
Master of Science

In  
Computer Science  
by

Kanimozhi Kalaichelvan

Approved by

Dr. Wook-Sung Yoo, Committee Chairperson

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Dr. Jamil M. Chaudri

Marshall University  
December 2019


## APPROVAL OF THESIS

We, the faculty supervising the work of Kanimozhi Kalaichelvan, affirm that the thesis, *What People Complain about Drone Apps? A Large-Scale Empirical Study of Google Play Store Reviews* meets the high academic standards for original scholarship and creative work established by the Master of Science in Computer Science and the Weisberg Division of Computer Science. This work also conforms to the editorial standards of our discipline and the Graduate College of Marshall University. With our signatures, we approve the manuscript for publication.

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## **ABSTRACT**

Within the past few years, there has been a tremendous increase in the number of UAVs (Unmanned Aerial Vehicle) or drones manufacture and purchase. It is expected to proliferate further, penetrating into every stream of life, thus making its usage inevitable. The UAV's major components are its physical hardware and programming software, which controls its navigation or performs various tasks based on the field of concern. The drone manufacturers launch the controlling app for the drones in mobile app stores. A few drone manufacturers also release development kits to aid drone enthusiasts in developing customized or more creative apps. Thus, the app stores are also expected to be flooded with drone-related apps in the near future. With various active research and studies being carried out in UAV's hardware field, no effort is dedicated to studying/researching the software side of UAV. Towards this end, a large-scale empirical study of UAV or drone-related apps of the Google Play Store Platform is conducted. The study consisted of 1,825 UAV mobile apps, across twenty-five categories, with 162,250 reviews. Some of the notable findings of the thesis are (a) There are 27 major types of issues the drone app users complain about, (b) The top four complaints observed are Functional Error (27.9%), Device Compatibility (16.8%), Cost (16.2%) and Connection/Sync (15.6%), (c) The top four issues for which the UAV manufactures or Drone app developers provide feedback to user complaints are Functional Error (40.9%), Cost (33.3%), Device Compatibility (23.1%) and ConnectionSync (16%), (d) Developers respond to the most frequently occurring complaints rather than the most negatively impacting ones.

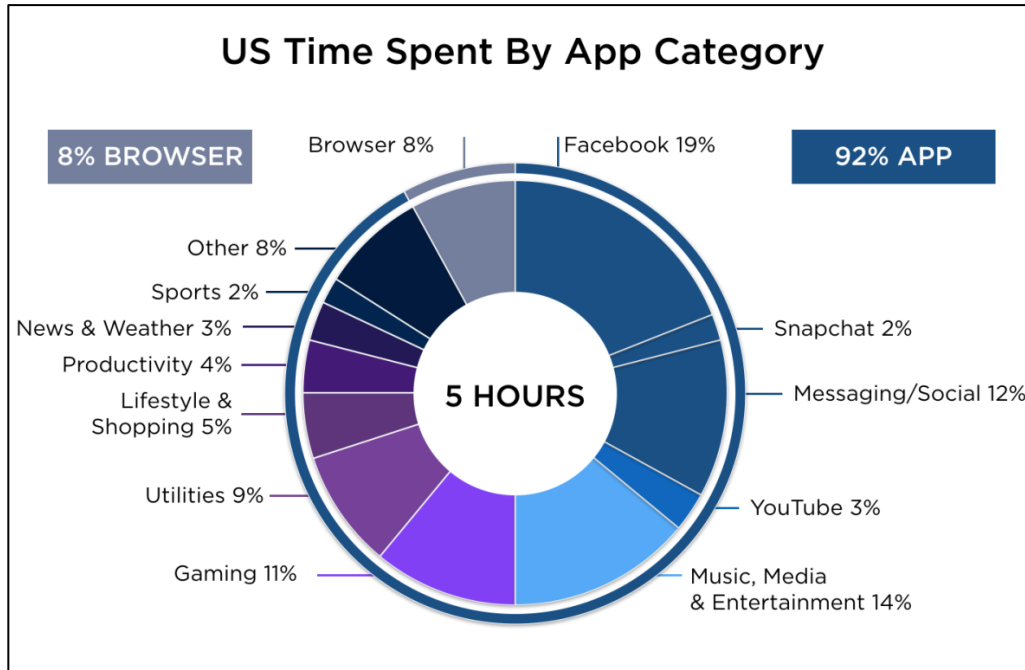
# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Motivation**

In recent years, with rapid technological advancements, mobile phones play a vital role in human life. The foremost advantage of the mobile phone is its portability. Though the main function of the mobile phone is telecommunication, it serves a lot more than that through providing mobile applications commonly referred to as “apps.” The apps are software programs that can be installed and run on mobile devices to accomplish certain tasks. Some examples of mobile apps are Gmail, WhatsApp, Instagram, Google maps, etc. Nearly every enterprise tries to expand its service to people by developing dedicated apps for their business.

In today’s fast-paced growth in technology, almost every trade and commerce branch develops apps for promoting and enhancing their sales. In fact, these days, many small businesses also, be it the banking industry, retail, boutiques, fashion, stationery, grocery or even coffee shops, each has its own dedicated mobile app. These apps are developed to provide easy access or service to the customers, such as banking apps, or to act as a merchandise platform to sell goods, such as boutique, or wardrobe apps or restaurants, or social media apps such as Facebook, WhatsApp to aid in consumer communication, or business productivity apps, or job portals, news apps, education apps, travel or entertainment apps, etc. Together with the tremendous growth in the number of apps and mobile phones opening a new means of communication between the distributor or service provider and the consumers, people tend to spend a lot of time on their mobile devices. Humans feel incapacitated in the absence of their mobile phones, even when performing their basic daily tasks. Statistics show that, on average, Americans spend nearly 5 hours on their mobile devices per day [50].



**Figure 1: Amount of Time spent on Mobile Phones**

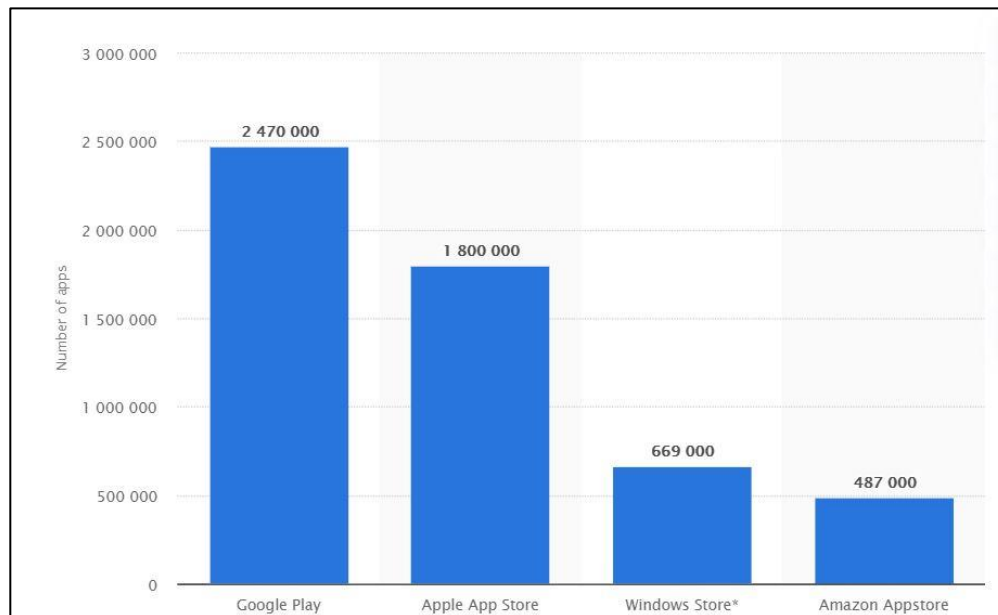
The graph illustrates the amount of time spent on mobile phones by an average American. <https://www.flurry.com/post/157921590345/us-consumers-time-spent-on-mobile-crosses-5>.

The percentage of time spent on mobiles either on various app categories or browsing is depicted in Figure 1. Mobile Users access these apps through mobile app distribution platforms (Mobile App Stores) that are based on the type of OS the mobile uses. The most popular app stores are the Google Play Store and the Apple App Store and the most popular app categories in both the Google Play and the App Store platforms are Games, Business, and Education [4].

### 1.1.1 Mobile App Stores

The Android Google Play Store and the Apple iOS App Store are the two largest distribution platforms for mobile apps (Figure 3 [48]), offering almost global coverage to a tremendous amount of people. According to recent statistics, Google Play Store has nearly 2.47 million apps, while 1.8 million apps are available for iOS as depicted in Figure 2 [3]. In 2018, the Apple App Store and the Google Play Store recorded 113 billion downloads of games and

apps worth \$76 billion, which is respectively 10% and 20% more than the previous year [27].



**Figure 2: Number of Apps in Various App Store Platforms as of 3rd quarter 2019**

The graph depicts the number of apps available across various mobile app stores (up to 2019).

<https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>

More than 3.9 billion people in the world have been estimated to be active Internet Users. Over 52% of the browsed websites are accessed using mobile devices [13]. The rise of the popularity of mobile internet is expected to keep its momentum through 2019. It is projected that 63.4% of mobile phone users will use it to access the internet as the year progresses. In 2020, the population using mobile internet service is expected to rise to 2.87 billion.

App developers, after the launch of their apps, perform App store optimization, which is the process of improving an app's ranking and discoverability in the app store. The higher the rank of the app store's search result, the more visible it is to potential users.

Research related to mobile app user reviews reveals that they play a major role in the success of an app. An app's visibility is, to a large extent, determined by its ratings and reviews. According to studies mentioned in [23], only 15 percent would consider installing apps having 2-

star, whereas 96 percent would favor apps having 4 stars. With the case of 3-star apps, 50 percent say that they would consider downloading. Thus, it can be seen that the higher the rating, more are the chances of users installing it, which is the reason why a majority (nearly 99) of the top 100 grossing apps on Google Play Store have 4-star ratings or higher.

Reviews apart from improving visibility also usher the user towards purchases or install from the mobile app store platform, boost conversion rates and enhance revenue. It also helps in grouping people across the world to build a supportive community for the app.



**Figure 3: Mobile Apps Importance**

The Figure illustrates that users purchase or install apps from mobile app store platforms.  
<https://www.istockphoto.com/>

According to the studies conducted by companies such as Vocus, Search Engine Land, and Dimensional Research, neglecting review comments can have dire consequences for the app [26]. The app layout from Instagram suffered from a large number of one-star reviews until it addressed user concerns.

Reviews are useful to new users to get an insight into the app as well as to developers to help them fix bugs and get an overall picture of the strength and weaknesses of the app. Reviews apart from being the source of credibility for the apps (the keywords present in review

comments) also contribute to the app's ranking in the Google Play Store. There exist numerous apps provided to mobile users from various platforms such as (iOS) App Store, (Android) Google Play Store, Amazon App Store, Blackberry World, Samsung Galaxy Store, etc. This thesis focuses only on the apps of Google Play Store Platform.

### 1.1.2 Google Play Store

Google Play, referred to as the Android Market, is Google's official store and portal for Android apps, games and other media content for the Android OS phone, tablet or Android TV device. Purchases made on the Google Play store can not only be shared and synced across mobile devices but can also be downloaded and stored on the Google cloud. As of 2017, Google Play features over 3.5 million Android applications [15], with 2.8 million apps available for download presently (2019 statistics) [16].



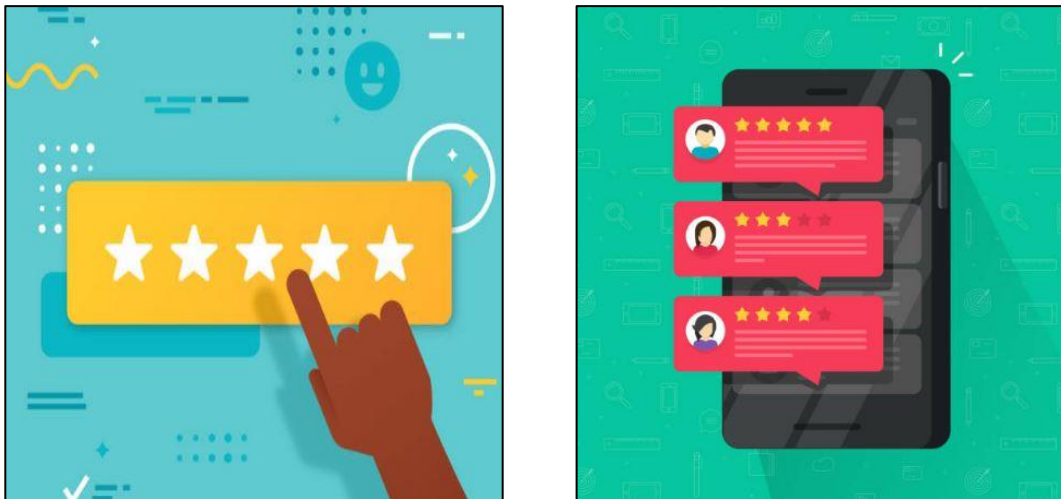
**Figure 4: Mobile Apps – User Feedback System**

The Figure depicts the rating and reviews feedback system of apps in mobile app stores.  
<https://www.istockphoto.com/>

There are free as well as paid apps available in mobile app stores. App developers can

push app upgrades (new versions of the apps that can be updated by the user), which can either fix previous bugs or may even cause new malfunctions.

App users can give feedback after using the app, as shown in Figure 4 [48]. Users can leave good or bad reviews. If customers have a good experience and do not face any issue with the app, they just keep on using the app, whereas dissatisfied customers often tend to leave a negative review after facing an unpleasant encounter. User feedback comprises both a rating and a written review. While the app review is optional when a mobile app user evaluates an app, the app rating is mandatory. App rating ranges from 1-star to 5-star rating (Figure 5) [48], 1 being the lowest and 5 the highest. The app ratings given by individual users will affect the overall score of an app. A low star rating of 1-star or 2-star means it is negative feedback since the user was dissatisfied with the app and the written review may contain information about the issue encountered, providing useful information to the developer that can aid in improving the app.



**Figure 5: Rating and Reviews**

The Figure depicts the ratings and reviews of apps in mobile app stores.  
<https://www.istockphoto.com/>

Since the thesis concentrates on what users complain about the drone apps of Google Play Store, only the low rated reviews are analyzed.

### 1.1.3 Drones

An unmanned aerial vehicle (UAV) (commonly called a drone) is an aircraft without a human pilot on board. Drones can be navigated via control from the ground, through software-controlled flight plans in their embedded systems, functioning along with onboard sensors and GPS. Small UAVs mostly use lithium-polymer batteries, while larger vehicles rely on conventional airplane engines. Some of these drones are equipped with cameras that allow the user to record videos or capture pictures. These drones are controlled by certified operators. Also, there exist many drone hobbyists.

Drones (Figure 6 [48]) are becoming more prevalent in recent years with new models being released with advanced new features. Although Drone hobbyists span across a range of skill levels, there are also drones that are tailored to newbies. Some drones are provided with a memory card that allows the user to record their video and then upload it to a computer.



**Figure 6: Drones**

The Figure displays an example of a UAV(unmanned aerial vehicle) or drone.  
<https://www.istockphoto.com/>

The rapid adoption of drones over the past decade has raised a number of securities, privacy and safety concerns. While many countries have UAV, regulations established to control



the usage of drones, some have not. As drone usage inflates, laws are also continuously updated. Prior to the use of a drone commercially or personally, it is crucial to check the laws of the country in which they are operated. In 2005, the FAA issued the guidelines on UAVs and issued its first commercial drone permit in the year 2006. A drone operation policy was then established in 2007. Then, the FAA Modernization and Reform Act of 2012 was released, which included Section 333, under which the U.S. Secretary of Transportation could approve commercial drone use on a case-by-case basis.

By 2014, only two companies in the U.S. were allowed to operate commercial drones. In 2015, an interim FAA policy governing the use of small drones for certain commercial uses under 200 feet was released, and the FAA announced it had approved more than 1,000 applications for commercial drones and continues to approve at a rate of approximately 50 applications per week. The next year, the FAA further relaxed its restrictions, and under its Small Unmanned Aircraft Regulation, Part 107, issued 3,100 drone permits in 2016 alone [45].

#### 1.1.4 Leading Competitors



**Figure 7: Top Competitors Drones Manufacture**

The Figure displays the Leading Competitor's (DJI and Parrot) drone apps.  
<https://play.google.com/store/apps/>

Major Competitors in Drone Market include DJI, Parrot, (Figure 7) [2] Yuneec, Kespry, Autel Robotics, etc.

#### **1.1.4.1 DJI Go 4**

DJI is the most successful drone manufacturer for both consumer and professional sectors since there were almost no major competitors, which made DJI hold a monopoly on this drone technology. The DJI Go 4 App is a must-have when flying DJI Drones. The DJI Go 4 App helps drone pilots with basic/advanced camera settings, intelligent flight modes and firmware updates that aids in flying drones smoothly. DJI is known mainly for its Mavic series. The Mavic series has become the classic drone for new to intermediate pilots and videographers, and they also launched the Mavic 2 Pro and Mavic 2 Zoom in late 2018 [5].

#### **1.1.4.2 Parrot**

DJI is by far the world's largest and most popular drone maker, with Parrot and other companies like 3D Robotics and the Chinese firm Yuneec existing in DJI's shadow for years. Parrot, a longtime competitor to Chinese drone giant DJI, also makes some of the best drones in the market. Their ANAFI camera drone is their most popular drone. Additionally, their Bebop 2.0 is even more robust, with 25-minute battery life and powerful motors for flight in higher altitudes. Parrot also designs, develops, and markets consumer products for smartphones and tablets other than consumer UAVs and drones. Recently, Parrot was one of the 6 companies selected by the US Department of Defense to build next-generation short-range reconnaissance aircraft for the US military [11].

### **1.2 Problem Statement**

The pace of innovation in the drone industry is increasing at a tremendous rate. Thousands of companies compete globally, with more emerging every day. Besides the explosion in production, prices have reduced exponentially. Drone technology has affected industries and research worldwide. Drones have remarkably enhanced our ability to collect high-

resolution spatial data at frequent intervals, eliminating the need for costly over-flights by manned aircraft. Additionally, drones are being incorporated with an array of sensors, cameras and software applications. Yet, there exists no study to date highlighting user issues related to drone apps that can assist app store stakeholders to produce quality apps.

Perhaps the most important advancement in drone technology is the launch of “smart drone” technology through which drones can interact with onboard computers, data collection devices, smartphone applications, as well as the cloud. Cloud integration will unleash the potential of drones for huge data collection and analysis. In addition, free and open software development kits and web APIs are currently accessible to drone enthusiasts, which will enable anyone with a basic background in coding to develop software (“drone apps”) that can be tailored to specific needs for industrial or research purposes. Some case studies of drone applications are given below [52].

### **1.2.1 Advancements & Case Studies of Drone Technology**

Some case studies [52] of drone usage are discussed in this section. With advanced improvements in camera quality and drones becoming easier to operate, drones have become more popular in the cinematography industry. However, the application of drone technology is not just limited to photography. In 2018, the Scotland police used drones in searching for missing people, tracking criminals, and traffic accident surveillance. On the other hand, Devon and Cornwall’s police performed drone trials, using drones fitted with cameras for observing traffic accidents, searching for missing people, and capturing crime scene photos. After the trials, the police department allocated a separate dedicated unit that employs drones in the force.

In 2015, 4 British Airways pilots opened a UK-based drone training school named “UAV Air” to aid people to learn to operate UAVs safely and legally. In 2017, the Brecon Mountain

Rescue Team declared a proposal to trial drones to help in improving the response to incidents. Zipline, the blood delivery supply service, has been using drone technology to transport blood supplies. The Alibaba-owned meal delivery service affirmed that they have received clearance from the Chinese government to start using food delivery drones in Shanghai. Car manufacturer SEAT has joined hands with Grupo Sesé to launch a drone-based parts delivery service, thereby reducing the delivery time down from one and a half hours to just 15 minutes.

Microsoft announced at one of its Build developer conferences that it was amalgamating with DJI to create drones for their enterprise. Google's parent company Alphabet launched an Amazon-style drone delivery project called 'Project Wing' with testing being held in Australia. Also, Alphabet has partnered with Australian-based Mexican restaurant Guzman Y Gomez to supply food and pharmaceutical company Chemist Warehouse to supply its products using drones.

BT, a telecommunications company has been experimenting with using drones to provide temporary internet coverage to hard-to-reach areas, disaster zones, and battlefields. In case of future floods or any natural disaster that impairs network connectivity in the area, UAVs could first assess the damage and then provide internet access to the area through tethered drones and balloons. In 2017, UPS revealed its first residential delivery drone. The drone itself will be set off from an electric van which has a recharging station facility for the battery-powered drones. In 2013, UK-based Japanese fast-food chain, YO! Sushi tested its waiter-drone delivery prototype.

In 2017, Balfour Beatty and West Sussex County Council trialed drone technology in bridge inspections. Dubai's Roads and Transportation Agency's head revealed in the World Government Summit, 2017, that Dubai will soon be launching people-carrying drones. In 2016, Amazon declared that it had started a drone delivery trial in the UK with two shoppers receiving

their items through drones. Israeli startup Flytrex has created a fully operational drone delivery service, in Iceland's capital, Reykjavik, that is being employed to deliver food and consumer goods, reducing a journey of up to 25 minutes to just four. Animal Dynamics (UK) startup has started creating military drones, inspired by dragonflies. Logistics firm DHL has been working on drone deliveries for a long time, delivering even to a pharmaceutical company based on an Island in Germany using its parcelcopter. Budget airline EasyJet plans to complete safety inspections on its aircrafts using drones.

While drone technology has many advantageous applications, there are a few threats as well. For example, Climate change protestors at Extinction Rebellion have threatened to cause disruption at Heathrow Airport by flying drones near the runway. Drone technology has led to security and privacy threats.

### **1.2.2 Studies on Drone Apps**

As the utmost importance of the drone industry is elaborated in the previous section, it is also expected to expand further into human lives as an inevitable technology. One such example is that the "FAA expects up to 1 million drones to be bought as presents this holiday season." Drones can also carry various kinds of sensors and reach places that most IoT (Internet of Things) devices cannot. Drones can also be used to predict the weather, replace traffic cameras, detect forest fires, scan buildings and landscapes to aid in the agriculture and structural health monitoring, search and rescue, and create 3D Maps by employing sensor fusion. Even though the drone software field requires significant research, there exist no previous works on drone apps of any Appstore. This thesis proposes to study a large number of drone apps from the Google Play Store and aims to uncover the issues mobile drone app users frequently complain about, the most negatively impacting types, the developer reply to the categories and the time taken to respond.

### **1.3 Thesis Scope**

The scope of the thesis is limited to apps from the Google Play Store alone. The thesis work does not cover the issues that may be prevalent in the generic drone industry or those present in other app store platforms. Since there is a limited time, it is not possible to manually categorize and label the entire dataset of drone app reviews mined from the Google app store; the thesis considers quantitative research methodology to extract samples that statistically are representative of the entire dataset. The scope of the thesis is fixed to the low rated user reviews since it assumes that only the user feedback having less than a 3-star rating contains complaints about issues while the 4-star and 5-star rating reviews are appreciative feedback. However, on some rare occasions, it is likely that even the high rated reviews may contain feature requests or update suggestions.

### **1.4 Organization of Thesis**

The organization of the rest of the thesis is as follows: Chapter 2 describes the related works for the thesis, describing various review or rating analysis of mobile app stores. Chapter 3 describes the methodology or mechanism of the designed system, which includes the scraper code implementation to collect the drone-related apps. Then the selection of the Google Play Store app categories, electing specific drone apps, and the process of the selected drone app's reviews and all other app details collection are described. Chapter 4 presents a statistical analysis of the dataset. Chapter 5 describes the research results and observations, presenting a descriptive analysis of the drone app reviews and developer replies dataset, discussing each of the complaint types in detail to give an overall picture of the issues posed by the drone app users in each complaint type, and Chapter 6 poses validity threats, conclusion, and future works.

## **CHAPTER 2**

### **RELATED WORK**

The work-related to the thesis falls into two major categories:

1. Work that focuses on mobile app user reviews and
2. Work-related to types of complaints in Android apps

#### **2.1 Work-Related To Mobile App User Reviews And Ratings**

Previous works on reviews of mobile apps affirm that user reviews play a vital role in the triumph of an app.

*Mudambi et al.* (2010) [41] analyzed 1,587 reviews from Amazon.com and found that moderate reviews are much more helpful than extreme reviews in case of experience goods and that reviews affected the sales of online products.

*Kim et al.* (2011) [32] carried out a study to unearth the key factors which impact the purchase decision of apps. They found that reviews of an app influenced its purchase the most. Some of the following factors were the app's usefulness, cost, and ranking.

*Harman et al.* (2012) [20] analyzed mobile app reviews and have found a strong correlation between downloads and ratings of apps.

*Ha and Wager* (2013) [19] investigated the reviews of some Google Play Store apps to analyze what users frequently write about in reviews. They found that users tend to be more concerned about quality compared to privacy and ethical issue. Among review ratings, they found that users who are evaluating the apps are doing so only when they are either extremely satisfied or dissatisfied. Also, they found out that most of the complaints that the app does not work have a 1-star rating.

*Pagano & Maalej* (2013) [44] describe how app store reviews could aid developers in

understanding user needs, thus facilitating app improvement. They analyzed both positive and negative reviews (all rating reviews) to discover the frequently discussed topics and found that the most popular was praise. They also inspected the co-occurrences of topics in the data sample and investigated which feedback types affect the overall rating of the apps. They found that feedback has a real impact on the market - positive reviews usually lead to higher application ratings and vice versa while feedback of greater length will probably be regarded as helpful by other users.

*Guzman and Maalej* (2014) [18] aimed to automatically identify application features, sentiments, and opinions about the features mentioned in consumer reviews. They do this by means of collocation finding, lexical sentiment analysis and topic modeling algorithms, which leads to a precision of 59% and a recall of 51%.

*Islam* (2014) [28] proposed a unified rating system by combining the star rating and a calculated numeric polarity of the review to generate an overall rating. They used sentiment analysis and an optimized probabilistic approach to obtain the probabilistic value of each review. Next, they normalized the star rating, and the average between these two gives an overall picture of the user's opinion.

*Malavolta et al.* (2015) [36] explored 3,041,315 user reviews of 11,917 free hybrid apps to analyze end users' perspectives of such apps compared to native apps. Their research findings are: hybrid development frameworks are considered as better suited for data-intensive apps. But hybrid apps fail to perform well with lower level platform-specific features. While hybrid and native apps appear similarly to consumers, in rare cases, end-users regard native apps as being better than hybrid apps in terms of performance and the occurrence of bugs.

*Monett and Stolte* (2016) [40] studied 1,760 reviews of 130 mobile apps to predict the



star rating based on their review text. As a result, apps could recommend users as to what rating has to be given for their text reviews.

*McIlroy et al.* (2017) [39] studied the importance of developers responding to mobile app user reviews. They realized that only 13.8% of a total of 10,713 apps responded to reviews with the highest response topic being feature requests (accounting for 7% of the total responses). Among those that reply, the major contributors are the apps with a mediocre number of downloads; the apps with a higher number of downloads do not reply. Also, the apps with a higher number of response percentages typically have a very lesser number of reviews. They conclude that the responses indeed lead to a significant positive change of 38.7% on the review ratings. Users tend to change their ratings after receiving a response.

*Finkelstein et al.*, 2017 [10] extracted blackberry app store data to analyze the correlation between the popularity of apps with its rating, price and claimed features. They found that there was a strong correlation between the rating and popularity and a mediocre correlation between claimed features and the price of apps.

*McIlroy et al.* (2016) [38] inspected the frequency of updates of 10,713 mobile apps from the Google Play Store. Approximately only 1% of the apps were updated weekly or more frequently while 14% are updated on a bi-weekly basis. They also found that nearly half (45%) of them are silent updates, containing no information on what has been changed. Among the non-silent apps, the most frequent communication (63%) is about bug fixing, the new feature follows with 35% and then improvement takes 30%. Bug fixes and new features or bug fixes and improvement co-occur the most (9%). Also, 31% of the apps are silently changing their app permissions at least once. They found that 81% of the frequently updated apps are found in the list of most popular apps of their category and tend to have a lower percentage of negative rating,

whereas only 45% of the rest of the apps (not frequently updated apps) are in the list of the most popular apps.

*Wang and Li* (2017) [51] investigate how the visual attributes of mobile apps impact the download behavior of users. They collected data from one of the largest Android app stores in China, Hiapk. Their results show that the aesthetic design of app icons plays a vital role in the number of users downloading the app. Apps designed with high colorfulness, high brightness, and low saturation have a greater number of downloads. They suggest that app designers should balance simplicity and complexity. Adding slight asymmetry to icon design can help amplify aesthetic preference and could cause a rise in the number of downloads.

*Abad et al.* (2017) [1] compared the Wizard-of-Oz (WOZ) technique (field study on 13 mobile app development teams) and User reviews technique (70,592 reviews of 40 apps available on the Google Play Store) to extract functional & non-functional requirements for the apps. They state that both these techniques can be integrated to reduce the communication gap between developers and users in the early stages of development, develop apps that meet the demand of stakeholders, and reduce the possibility of requirement changes in later stages.

*Day and Lin.* (2017) [7] collected 196,651 reviews from the Google Play Store and performed sentiment analysis on them. Their results prove that the use of deep learning for sentiment analysis (Bi-LSTM) achieves 94% accuracy which outperforms Naïve Bayes's accuracy of 74.12% and Support Vector Machine's accuracy of 76.46%.

*Martin et al.* (2017) [37] provides a survey paper that contains a more exhaustive list of studies conducted on iOS Apps.

*Lai et al.* (2018) [34] studied 4,480 user reviews from a health and fitness-tracking app (Google Fit) from the Google Play Store using text mining. They categorized feedback into

health-related and fitness related and created concept maps on them. The results indicate that the users of health and fitness-related apps are more concerned about their physical activity and physiological records and the UI for these records. These records involve measurements related to time, distance and calories burned. Also, the connectivity between the mobile and wearable devices seems to be significant for the users. In the case of “health”- related feedbacks, many users were dissatisfied with health management, since there were lots of words with negative emotion. Besides, the developers of Good Fit should also pay attention to the app compatibility with mobile devices. In the “fitness”- related feedbacks, users tended to be more concerned about the connectivity and data synchronization.

*Srisopha and Alfayez* (2018) [47] studied open-source software (OSS) apps from the Google Play Store to investigate if there exists a correlation between customer satisfaction and the application’s internal quality characteristics. They classified reviews into four basic (Intention) categories - problem report, improvement request, inquiry, and others. They were classified with respect to software quality (SQ) such as - functional suitability, performance efficiency, usability, portability, compatibility, reliability, maintainability, and security and also based on Sentiment - positive, neutral, and negative. “Negative sentiment,” “Problem report,” “Dissatisfaction with Functional suitability,” “Dissatisfaction with Performance efficiency” and “Dissatisfaction with Reliability” had a strong positive correlation with “PD” (violations reported by PMD tool - Empty code, Naming, Braces, Import statements, Coupling, Unused Code, Unnecessary, Design, Optimization, String and StringBuffer). The observations implied that, higher the violations reported by PMD, higher are the chances that the app release gets these types of sentences. Similarly, “Dissatisfaction with Performance efficiency” and “Dissatisfaction with Reliability” gave a notably strong positive correlation with “CS” (SonarQube Tool Metric –

Number of code smells). Although “Positive sentiment” showed a negative correlation with “CS” and “PD” (i.e., less code quality violations, more positive reviews), the correlations were not statistically outstanding. No correlation was found between each review sentence type and “FB.” (FindBugs Metrics - Dodgy code, Bad practice, Malicious code, Performance, Correctness, Security, Multithreaded correctness, Internalization). Their results indicate that, to some extent, user ratings correlate with the application’s internal characteristics.

*Gao et al.* (2018) [14] proposed an automated framework IDEA (IDentify Emerging App issues) that identifies emergency issues based on online review analysis. According to them, for 36,000 product reviews perversion, IDEA achieved a high throughput (about 160 reviews per second) and consumed only 1.02GB of memory on average. Thus, the IDEA was proved to be effective and efficient in swiftly discovering urgent app issues for developers in the industry.

*Hassan et al.* (2018) [22] studied 4.5 million reviews with 126,686 developer responses of 2,328 top free apps from the Google Play Store in an attempt to explore more about the dynamic nature of the review-response mechanism and that responding to a review often has a positive effect on the rating that is given by the user to an app (stated in their previous paper). They found that the probability of a developer responding to a review increases as the review content gets longer or as the review rating gets lower. The top developer replies to reviews were to thank them for using the app and to ask for more details about the reported issue. Their findings state that it can be worth the effort for app developers to respond to reviews since that may lead to an increased app rating in the future.

*Hassan et al.* (2018) [21] performed a manual analysis of the release notes and negative reviews of the top 250 bad updates to study the topics users complain about after a bad update and how the developers recover from them. The results reveal that functional issues, crashes,

additional cost and user interface problems are the most frequently raised complaint issues. They measured the differences in the negativity ratio (NegDiff) as the negativity ratio of a bad update - the negativity ratio of the fixing update and found that the cases where developers mentioned explicitly that they addressed the issues of a bad update have a higher difference in the negativity ratio than the cases where developers do not mention that the issues were addressed. Therefore, it is suggested that developers do mention explicitly in their release notes that an issue was addressed to persuade mobile users to download the updates and eventually update their evaluation leading to an increase in overall app rating.

*Tong et al.* (2018) [49] proposed CrowdApp to automatically recognize the significant user reviews of apps, which can help developers handle a huge amount of user reviews and determine those feedback that are most pertinent for app revolution. The proposed tool first discovers app aspects in user reviews by employing a bootstrapping-based algorithm and identifies user reviews with the discovered app aspects via sentiment analysis. Later, it creates an econometric model to sort these user reviews, which effectively helps app developers to deal with the most important app issues.

*Greenheld et al.* (2018) [17] aimed to develop a system to automatically generate a response for app reviews. The system compares each of the reviews that have a reply with the new review, computing the cosine similarity score between each pair. The response, which has the largest similarity score, and is over a specific threshold (0.35) is returned. It also adds the common social norms of communication in the reply text. If a match is not found, a generic response template is sent. Three aspects of the system were inspected - usability, cognitive load, and performance. The newly developed system was compared with the traditional method. With reference to all of the three aspects, there were statistically remarkable differences between the

two systems, with the proposed system being preferred by the users over the traditional system. They also observed a word acceptance rate of 96%.

*Hu et al.* (2018) [24] examined 34,258 ratings and 9,902 1 & 2-star reviews of 19 cross-platform apps from the Google Play Store and the iOS app store to investigate whether cross-platform apps achieve a consistent level of star ratings, user review ratings, and consistent most negatively impacting complaints. Their results demonstrate that at least 79% of the studied cross-platform apps did not receive the same distribution of star ratings on Android and iOS, 68% of the apps have a varying distribution of complaint types between their Android and iOS counterparts and negative impact ratios differ even for apps of which the spread of star ratings across platforms are identical.

*Nayebi et al.* (2018) [42] studied 30,793 apps for analyzing the relationship between tweets and reviews. They performed in-depth content and sentiment analysis on 1,267,895 reviews from the Google Play Store and 358,860 tweets from Twitter. They found that 41.1% of the reviews and 36.9% of tweets are mainly bug reports, while 17.5% among the informative tweets and 19.3% among the informative reviews are app feature requests. Moreover, while 40.78% of feature requests and bug reports are common between app-related tweets and app store reviews, of the 70 apps being analyzed, a total of 198 feature requests and 246 bug reports were found in the app related tweets that were not present in the app store reviews. While 22.4% of feature requests came from Twitter alone, 34.09% came from app store reviews alone. Also, 12.8% of bug reports were mined from Twitter only while 30.59% only came from the app store. On the other hand, 43.51% of feature requests and 56.61% of bug reports were commonly found in both Twitter and the Google play store. Thus, they conclude that app store mining alone is not

enough to improve the apps; the developers need to follow other sources of user feedback also.

*Noei et al.* (2019) [43] studied 435,628 reviews from 49 apps (of 10 categories) from the Google Play Store. After preprocessing the data, they perform topic modeling to identify the categories of user feedback. They infer that the key topics of each category are the topics that share a notable relationship with star-ratings. The key topics were not the most frequent topics of user-feedback. For 77% of the apps on average, having a similar release note to the key topics shares a statistically remarkable relationship with positive changes in star-ratings. Hence developers should consider the key topics carefully for future releases to reduce the risk of receiving low star-ratings.

*Hu et al.* (2019) [25] investigated 68 hybrid apps from the Google Play Store and iOS app store to determine whether they achieve consistent star ratings and user reviews across Android and iOS platforms. The results showed that although hybrid apps are better at providing consistent star ratings and user reviews than cross-platform apps, hybrid apps do not guarantee such consistency. Hence they conclude that developers should be heedful of the ratings and reviews of their apps across platforms so that they can act accordingly when platform-specific issues arise.

*Dalpiaz & Parente* (2019) [6] proposed a tool called RE-SWOT, which combines NLP algorithms with information visualization techniques to extract requirements from user feedback through competitor analysis. They conducted 3 semi-structured interviews with three product management members from various app developers. All 3 interviewees responded positively about the usability and interactive aspect of the tool. They mentioned that the automated detection of phrases from the reviews is useful to work with huge size of reviews, the possibility to zoom into the details could positively affect the communication between stakeholders, and the

tool is useful to become aware of features from the competitors that were previously unknown which could possibly impact their app development. One interviewee noted that a competitor was organizing a promotion because people were commenting on promo codes. They also mentioned some improvements to the tool.

*Raja and Pushpa* (2019) [33] presented the DIversifying Personalized Mobile Multimedia Application Recommendation (DIPMMAR) tool which generates app recommendations by combining rating, review text, app description, and their popularity. Their system achieved 80% precision even though the application rating ratio was only 0.2, but the existing recommender system obtained only 75% precision. (Application rating ratio is the ratio between the number of rated applications and the total number of applications). With an application rating of 1.0, it achieved a precision of 0.89. Also, the DIPMMAR system attained a recall of 75% with a recommendation list of 5 and increased to 82% approach when the size of the recommendation list is 25.

## **2.2 Work-Related To User Complaint Types**

*Fu et al.* 2013 [12] have predicted user sentiments from user reviews and also have analyzed Text-Rating-Inconsistency. They have performed Topic Modelling on 1 and 2-star ratings to discover what the most common types of complaints are in each category of apps in order for developers to get an insight into which areas need improvement.

*Khalid.* 2013 [30] studied app store 1 and 2-star reviews to identify what iOS app users frequently complain about. They found that Functional error, Feature request, and App crashes complaints account for about 50% of the total complaints. They also found that 11% of the complaints occur after an app update thus emphasizing the need for regression testing before



updating mobile apps.

*Khalid et al.* (2015) [31] studied low rated reviews of 20 free iOS apps. They found that functional error, feature request, and app crash were the categories that were often complained about, whereas privacy and ethical, feature removal and hidden costs complaints were the most impactful ones as they received more 1-star ratings, which led to a reduction in the overall rating of an app.

*Di Sorbo et al.* (2017) [8] introduced an approach named SURF - Summarizer of User Reviews Feedback in which reviews were classified into their respective 12 categories SURF.

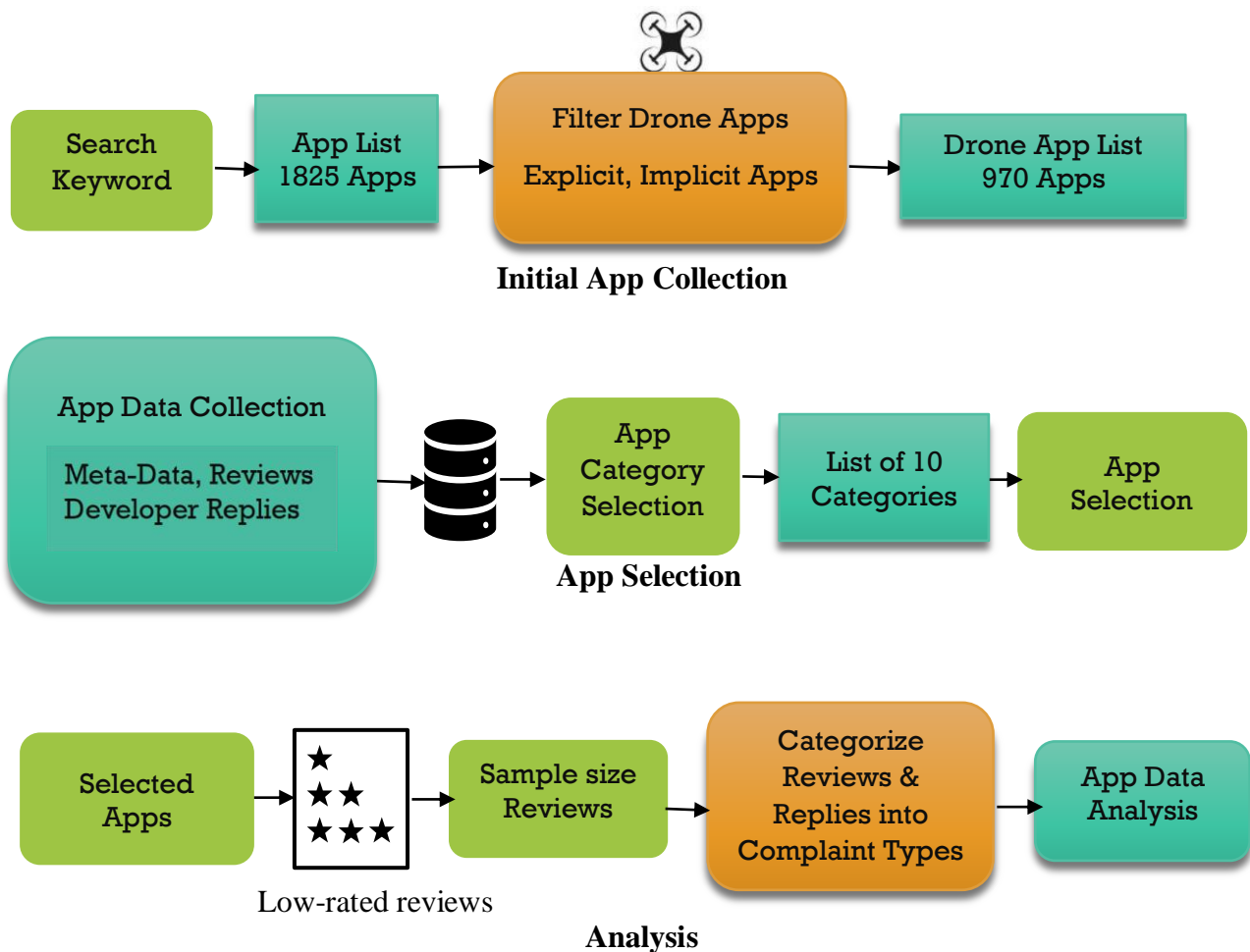
*Jha and Mahmoud* (2018) [29] studied 19 Android wearable apps reviews, and developer replies to analyze what wearable apps consumers complain mostly about, what complaint type has a more negative impact, and which receives most developer replies. They conclude that Functional errors, Lack of Functionality and Cost categories receive most complaints whereas Installation Errors, Device Compatibility, and Privacy & Ethical Issues are the ones with a higher negative impact. Besides, 11% of the complaints account for update related issues hence highlighting the need for regression testing before the release of an app. Also, according to their study, developers mostly reply to complaints related to Privacy & Ethical, notification, and Performance Issues while their response is mostly a direct solution or requesting details or to notify that a solution is in progress.

## CHAPTER 3

### METHODOLOGY

#### 3.1 Data collection

In this section, the collection of the drone-related apps, the drone app's reviews, and replies dataset from the Google Play Store are described. The app details, app permissions and app version details are also collected for a selected group of apps. The software code used in the thesis to collect data of the drone app is built around a Google Play Store scraper [9].



**Figure 8: Overall Methodology of the Thesis**

The Figure illustrates the Overall Methodology employed in the thesis. It comprises of three phases: App Collection, App Selection, and Analysis.

### 3.1.1 App Collection

The overall methodology of the thesis is illustrated in Figure 8. In this thesis, an open-source scraper [9] is used. Since there is no defined category provided for drone apps, search terms to seek related apps were employed. This scraper has a method for “search” where search terms such as ‘drone,’ ‘UAV’ can be provided. It basically does a search query on the Google Play Store website. Some of the search terms were ‘drone,’ ‘UAV,’ ‘drone controllers,’ ‘drone simulators’ and ‘drone games.’ A Breadth-First-Search was executed and all apps fetched by the search terms were crawled.

#### 3.1.1.1 App Terminologies

*App*: Mobile application (software) that helps the mobile user to perform some task.

*AppTitle*: Name of the app as given in the Google Play Store.

*AppGenreID*: Category of the app. App stores assign apps to categories in a method of grouping the apps based on features and functioning.

*Docid*: a unique identifier for each app in the Google Play Store.

*Hreflink*: URL of an app in the Google Play Store.

*Developer*: The developer of the app. The developer can be a company or an individual.

*AppPrice*: Cost of the app. (Apps can be free of cost or can charge an amount of money to download and use it.)

*AppScore*: The overall rating of an app in the App Store.

*Review*: The app user can phrase their experience (positive or negative) and post it on the app page of the Google Play Store.

*ReviewScore*: The score for the app given by the app user. (The user can also post an optional written review regarding his/her experience with the app).

*AppSummary*: Description of the app, a brief narration of the features and functioning of the app.

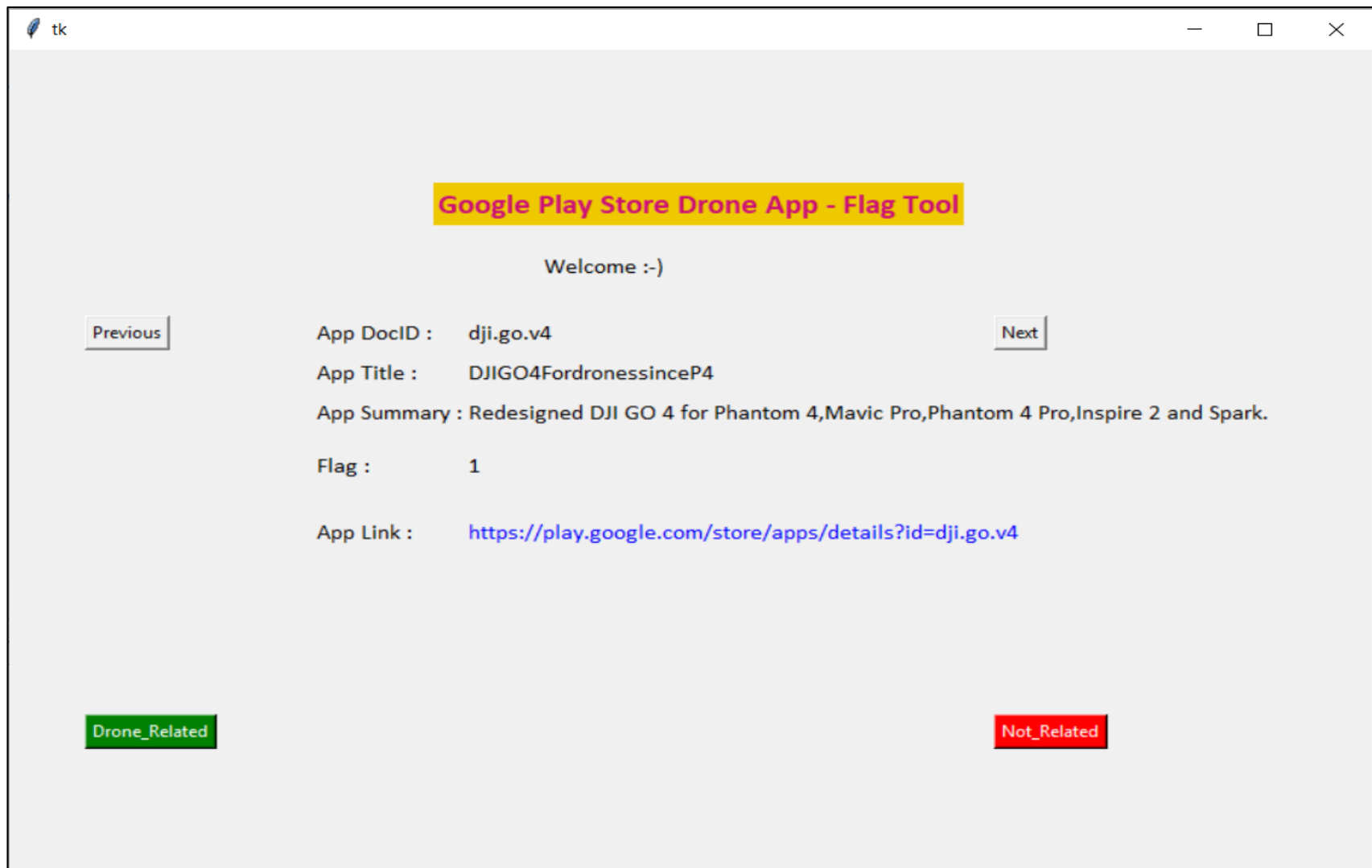
*Version*: The app is initially released and then updated to new versions with patches to update the bugs or added features and functionality.

*Downloads/Installs*: The number of unique email ids that have downloaded the app.

The major details of the Google Play Store apps such as docid, hreflink, developer, appPrice, appSummary, appScore were all collected through the scraper. In order to get wider coverage and to increase the number of apps being scraped, the free and paid apps were scraped separately using the price: 'free' and price: 'paid' options in the search method provided in the scraper. A total of 1825 apps were collected.

### **3.1.2 Preprocessing**

The dataset has composed a total of 1825 apps, most of it is related to UAV. But due to noise (unwanted items), some unrelated apps were also collected. For example, few apps such as '*AndroBagPipe*' had the word drone ('drone' related to bagpipe music) in the app description, but these apps were not related to UAV. Few apps such as '*UAVAthletics*' had the word UAV in the app name itself (university name was UAV - University of Antelope Valley) but the app was related to athletics. On the contrary, some apps which were related to UAV and drones did not have the major terms 'drone' or 'UAV' in the title or docid or description. Hence arose the problem of how to determine which apps were drone-related and which were not. To solve this, a GUI tool was created for sorting out the apps. The GUI tool, portrayed in Figure 9 would fetch all the app details such as app title, summary and hreflink which opens the app link in the Google play store website in a browser window so that the grading person can click on links in the GUI, view description of the app in the Web browser and grade the apps as related or not in the GUI.



**Figure 9: GUI for Drone App Classification**

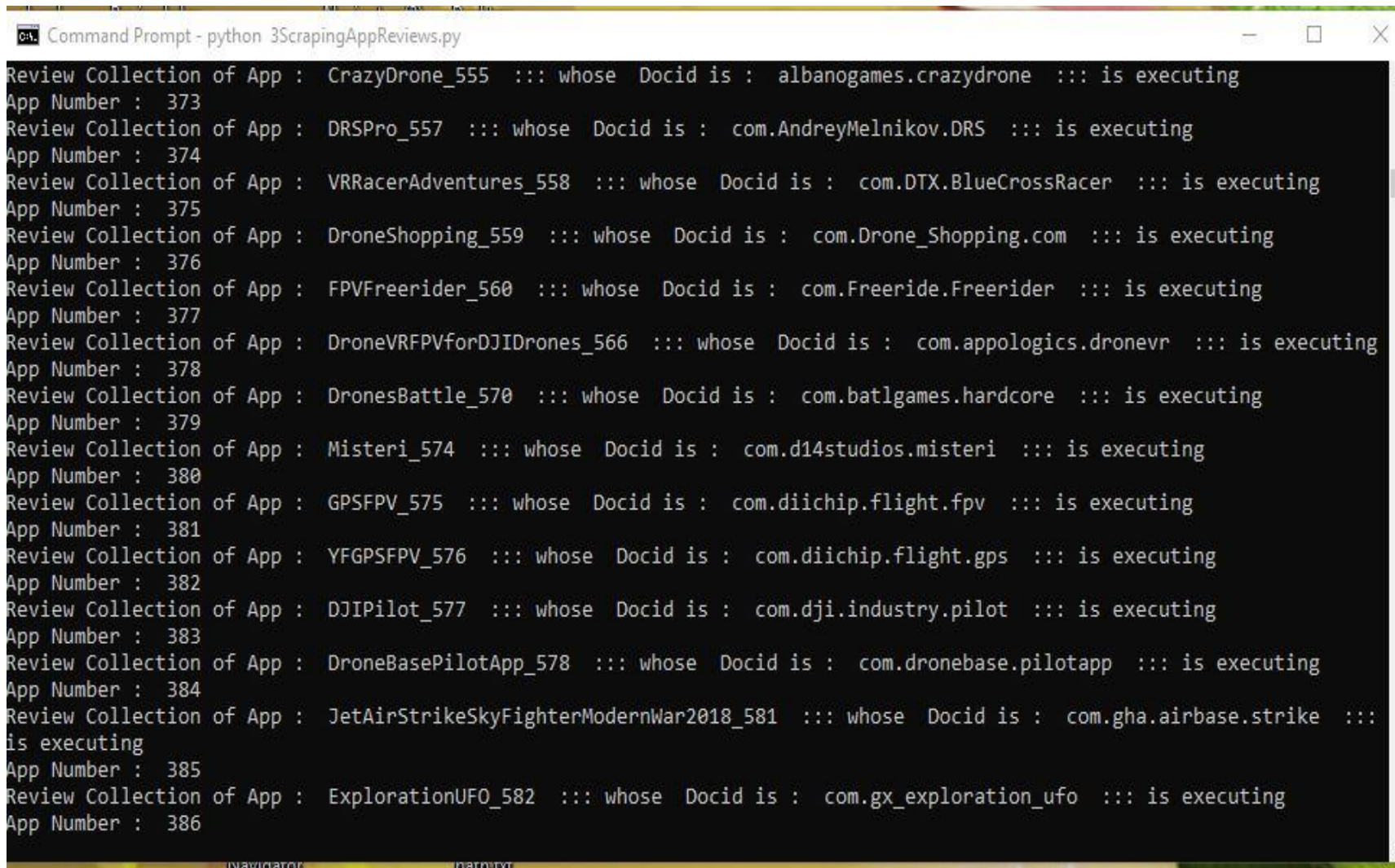
The Figure displays the GUI created to enable classifying the collected apps into either being Drone-Related or Not Drone-Related

Two members from the lab manually graded apps as related to Drones (1 flag) or not (0 flag). Some of the apps were tricky to grade since they were not directly related but played a small role such as drones were present as part of a game. In this way, 100 apps were graded through discussion between the grading members.

A total of 970 apps were graded as explicitly or implicitly related to Drones or UAVs. For example, DJI GO 4 app developed by DJI TECHNOLOGY CO., LTD is an explicit drone-related app whereas the Crazy Drone app developed by Albano Games is not related to real-life drones but is of an implicit type - a kind of drone simulation game. App details such as number of minimum installs, score, number of reviews, genre, price, currency, In-app purchase, ad support information, app size, developer details, price details, content rating details, privacy policy links, version, and updated dates of all the 970 apps were collected. App permissions of the 970 apps were also collected.

### **3.1.3 Review & Developer Reply Collection**

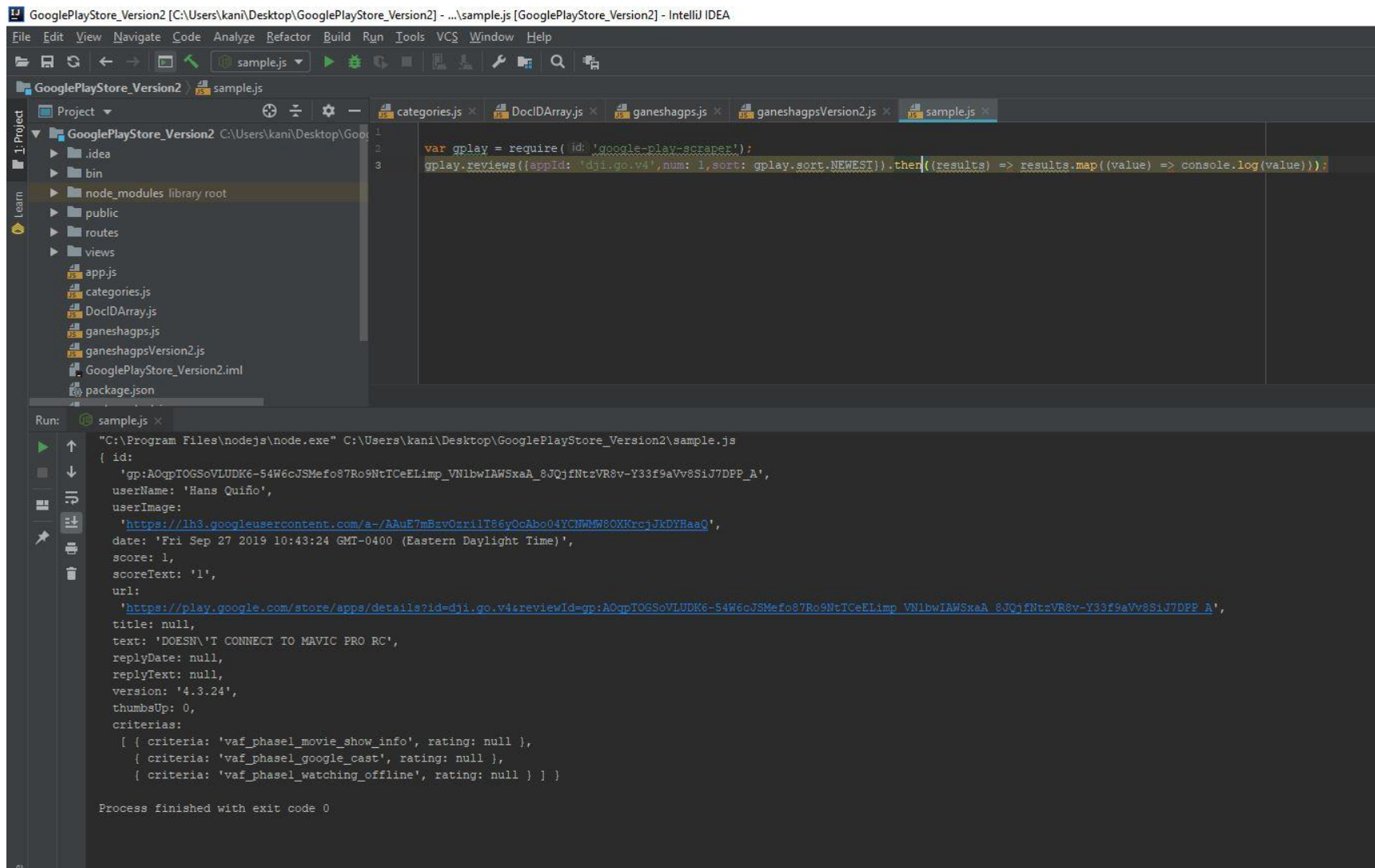
Review Collection was implemented for the 970 apps. Since some of them did not have any review at all, 739 distinct app reviews were collected initially. The app reviews were collected from July 10, 2019, to October 1, 2019. The review collection of the drone apps is demonstrated in Figure 10. Slowly a few other apps received reviews and distinct appdocids for which reviews that were collected rose to 752. A total of 162,250 app reviews were scraped. Out of those, 110,775 reviews had a review rating of greater than 3 i.e., positive feedback, while 51,475 were 1 or 2 or 3-star reviews i.e., negative feedbacks. Among the 752 apps, 380 apps had less than 10 reviews per app. On the other hand, only 130 apps had greater than 100 reviews per app, which suggests that apps with a greater number of downloads resulting in a greater number of reviews were only a handful. The sample of an app review structure is given in Figure 11.



```
Command Prompt - python 3ScrapingAppReviews.py
Review Collection of App : CrazyDrone_555 ::: whose Docid is : albanogames.crazydrone ::: is executing
App Number : 373
Review Collection of App : DRSPPro_557 ::: whose Docid is : com.AndreyMelnikov.DRS ::: is executing
App Number : 374
Review Collection of App : VRRacerAdventures_558 ::: whose Docid is : com.DTX.BlueCrossRacer ::: is executing
App Number : 375
Review Collection of App : DroneShopping_559 ::: whose Docid is : com.Drone_Shopping.com ::: is executing
App Number : 376
Review Collection of App : FPVFreerider_560 ::: whose Docid is : com.Freeride.Freerider ::: is executing
App Number : 377
Review Collection of App : DroneVRFPVforDJI Drones_566 ::: whose Docid is : com.appologics.dronevr ::: is executing
App Number : 378
Review Collection of App : DronesBattle_570 ::: whose Docid is : com.batlgames.hardcore ::: is executing
App Number : 379
Review Collection of App : Misteri_574 ::: whose Docid is : com.d14studios.misteri ::: is executing
App Number : 380
Review Collection of App : GPSFPV_575 ::: whose Docid is : com.diichip.flight.fpv ::: is executing
App Number : 381
Review Collection of App : YGPSFPV_576 ::: whose Docid is : com.diichip.flight.gps ::: is executing
App Number : 382
Review Collection of App : DJIPilot_577 ::: whose Docid is : com.dji.industry.pilot ::: is executing
App Number : 383
Review Collection of App : DroneBasePilotApp_578 ::: whose Docid is : com.dronebase.pilotapp ::: is executing
App Number : 384
Review Collection of App : JetAirStrikeSkyFighterModernWar2018_581 ::: whose Docid is : com.gha.airbase.strike :::
is executing
App Number : 385
Review Collection of App : ExplorationUFO_582 ::: whose Docid is : com.gx_exploration_ufo ::: is executing
App Number : 386
```

**Figure 10: Review Collection Process**

The Figure displays the process of collecting Reviews for all 970 apps. The app serial number, app title, and docid are displayed in the python code run console.



**Figure 11: Sample of Review Structure**

The Figure illustrates the Structure of the scraped App Review. The review belongs to DJI Go 4 App.



### 3.2 Review Selection

**Table 1: App Category Selection**

The Table lists the various Google Play Store categories across which all the collected drone-related apps lie in.

AppGenreID	Paid_apps		Free_apps		Number_of_Apps
GAME	56	+	270	=	326
ENTERTAINMENT	15	+	227	=	242
TOOLS	20	+	102	=	122
PHOTOGRAPHY	12	+	73	=	85
MAPS_AND_NAVIGATION	4	+	17	=	21
EDUCATION	6	+	14	=	20
LIFESTYLE	4	+	15	=	19
SHOPPING	0	+	17	=	17
VIDEO_PLAYERS	5	+	12	=	17
PRODUCTIVITY	4	+	12	=	16
BUSINESS	0	+	13	=	13
LIBRARIES_AND_DEMO	0	+	12	=	12
WEATHER	2	+	9	=	11
PERSONALIZATION	1	+	8	=	9
BOOKS_AND_REFERENCE	0	+	8	=	8
AUTO_AND_VEHICLES	0	+	7	=	7
MUSIC_AND_AUDIO	1	+	4	=	5
SPORTS	3	+	2	=	5
NEWS_AND_MAGAZINES	1	+	3	=	4
COMMUNICATION	0	+	3	=	3
SOCIAL	0	+	3	=	3
TRAVEL_AND_LOCAL	1	+	1	=	2
ART_AND_DESIGN	0	+	1	=	1
COMICS	0	+	1	=	1
EVENTS	0	+	1	=	1
Totals	135	+	835	=	970

The first step in the review selection process was to select the app categories. The categories of apps were sorted in descending order according to the number of apps in each of them as shown in Table 1. The top ten categories were: Game, Entertainment, Tools, Photography, Maps\_and\_Navigation, Education, Lifestyle, Shopping, Video\_Players, and Productivity. But the Shopping category did not have paid apps and Productivity category paid apps did not contain any reviews at all. Hence a decision to skip the categories which had no paid apps or which had no reviews in their apps was taken and this led to further choose two more categories - Weather and Sports.

Subsequently, from the selected categories, 8 apps (top 2 apps with highest number of reviews in each subcategory were chosen) from each category - 2 free apps of app score less than or equal to 3, 2 free apps of app score greater than 3, 2 paid apps of app score less than or equal to 3 and 2 paid apps of app score greater than 3 were chosen. Some subcategories' apps did not have reviews. Hence a total of 66 apps with reviews were selected. After this step, the thesis has to choose the reviews from all these apps.

Among the reviews, the 4- and 5-star ratings mostly contain good remarks about the app and do not contain any information about bugs that is useful to the developer. Hence the reviews that have a rating of above 3-star are eliminated in the thesis study. Only the reviews with a rating below or equal to 3-star contain useful information such as functionality errors and complaints about the usage of the apps. Among all reviews, these accounted for about 51,475.

Manual classification of all the reviews is a tedious and time-consuming process. Hence the thesis selected a random statistical representative sample of reviews [46] for each app and classified them alone manually. The sample reviews are selected to achieve a 95% confidence level and a 5% confidence interval [31].

Sample Size Calculator - Config X

https://www.surveysystem.com/sscalc.htm

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**Sample Size Calculator**

This Sample Size Calculator is presented as a public service of Creative Research Systems [survey software](#). You can use it to determine how many people you need to interview in order to get results that reflect the target population as precisely as needed. You can also find the level of precision you have in an existing sample.

Before using the sample size calculator, there are two terms that you need to know. These are: **confidence interval** and **confidence level**. If you are not familiar with these terms, [click here](#). To learn more about the factors that affect the size of confidence intervals, [click here](#).

Enter your choices in a calculator below to find the sample size you need or the confidence interval you have. Leave the Population box blank, if the population is very large or unknown.

**Determine Sample Size**

Confidence Level: ☒ 95% ☐ 99%

Confidence Interval:

Population:

[Calculate](#) [Clear](#)

Sample size needed:

**Figure 12: Review Sample Size Calculation**

The Figure demonstrates the number of sample reviews calculation for each of the selected apps.

**Table 2: Sample Review Size Calculation**

The Table is an example of a sample review size calculation from the total population size of each app's reviews.

AppName	AppDocID	Pop Size	Sample Size	DateSpan From Date	DateSpan To Date
DJIGO4FordronessinceP4	dji.go.v4	6989	364	2016-12-17	2019-09-23
DJIGOForproductsbeforeP4	dji.pilot	5847	361	2015-04-16	2019-09-30
DroneShadowStrike	com.reliancegames.drones	5545	359	2014-10-18	2019-09-16
FreeFlightPro	com.parrot.freeflight3	2373	331	2014-08-02	2019-09-21
GalaxyForceFalconSquad	invaders.os.galaxy.space.shooter.attack.classic	1762	316	2019-01-06	2019-09-28
B4UFLY	gov.faa.b4ufly2	758	255	2016-03-14	2019-09-14
LitchiforDJIMavicPhantomInspireSpark	com.aryuthere.visionplus	709	249	2015-04-28	2019-09-30
Tello	com.ryzerobotics.tello	597	234	2018-02-23	2019-09-30
SkyViperVideoViewer	com.newskyviper	521	221	2015-10-08	2019-08-27
HoverDroneUAVpilottapp	com.analyticadevelopment.android.hover	363	187	2015-01-27	2019-09-28
AirMapforDrones	com.airmap.airmap	233	145	2016-11-01	2019-09-21
DroneDeployMappingforDJI	com.dronedeploy.beta	192	128	2015-11-21	2019-09-27
AviaWeatherMETARTAF	com.mytowntonight.aviationweather	175	120	2014-02-09	2019-09-26
EasyCapViewer	com.easycap.viewer	162	114	2015-03-01	2019-09-13
DroneShadowStrike3	com.reliancegames.drones3	161	114	2019-07-23	2019-09-30
BreezeCam	com.yuneec.android.flyingcamera	137	101	2016-09-21	2019-08-15
DoFun	com.zerotech.cameratime	129	97	2016-11-15	2019-09-27
HFun	com.h8	128	96	2018-04-29	2019-09-12
UAVForecastforDJIQuadcopterUAVDronePilots	com.uavforecast	113	87	2015-11-12	2019-09-14
ARPro3forParrotDrones	com.shellware.arpro3	92	74	2016-02-02	2019-09-27

A python code that used selenium to access sample size calculator website and then save the sample size on the database (as shown in Figure 12) was developed. Then extraction of the sample size reviews from each app was performed and later started classifying them to their

respective complaint types. The total of all apps' sample size came up to 4802 reviews among which 1364 reviews had developer replies.

### 3.2.1 Review Complaint Types

The selected reviews have to be classified into their respective complaint types. An app user may complain about a lot of issues in their one review itself. Hence a review can be classified into more than one complaint type.

On analysis, 27 distinct complaint types as described in Table 3 were found to exist in drone-related apps reviews. They are as follows: additional cost, advertisements, app crash, battery, cellular data usage, connection & sync, cost, customer support, device compatibility, device storage, feature removal, feature request, functional error, installation problems, lack of functionality, missing notification, network problem, performance, privacy ethical, resource-heavy, spam notification, user interface, update/version issues, uninformative, uninteresting content, unresponsive and usability.

**Table 3: Review Complaint Types Description**

The Table provides the description and an example of each Review complaint type

Complaint Type	Description	Example
Additional_Cost	The user complains not about game cost, but about hidden additional costs in various levels of the game.	<i>like the game but once u get into harder levels u have to buy the good planes or u wont get any further.</i>
Advertisements	The user complains about advertisements while using the app.	<i>Fun but way too many ads</i>
App_Crash	The user complains about app crashes.	<i>Crashes everytime i use it!!!!!!!</i>
Battery	The user complains about the battery drain.	<i>constantly drain my battery</i>

Cellular_Data_Usage	The user complains about heavy data usage by the app.	<i>i noticed TOO HUGE data usage</i>
ConnectionSync	The user complains about connectivity or syncing problems with the drone.	<i>Can not get app to connect to P4</i>
Cost	The user complains about app costs.	<i>Because the manufacturer is selling hardware and a minimum app we hav to spend more mony for buy an app to fly this , its cheating</i>
Customer_Support	The user complains about customer support response delay or being unhelpful.	<i>SkyRocket Toys customer-support is not helpful.</i>
Device_Compatibility	The user complains about the app not being compatible with their phone's OS or hardware.	<i>not compatible with Android 10. Good that I checked it before buying the drone</i>
Device_Storage	The user complains about storage problems.	<i>i keep getting the no storage error but storage is present. what could the problem be?? I have over 11 GB free but i still get that error, why doesnt it pick the storage????</i>
Feature_Removal	The user suggests removing a feature from the app.	<i>please remove data synchronization as it is rendering my bebop 2 useless without internet.</i>
Feature_Request	The user requests to add a new feature to the app.	<i>Needs facebook live feature. Yuneec.....dont be an apple only company like dji.</i>
Functional_Error	The user complains about any error in the functioning of the app.	<i>Video streaming not working for Moto X4. Clicks are fine.</i>
Installation_Problems	The user complains about app installation issues.	<i>App wont install have no idea what its like</i>
Lack_of_Functionality	The user complains about the lack of functionality.	<i>I cant Play Offline !! Every Single Levels Are Need To Download Why ??</i>
Missing_Notification	The user complains about missing notification.	<i>Never received OTP in my mobile number</i>

Network_Problem	The user complains about network issues.	<i>network unavailable - phone is connected to the internet correctly</i>
Performance	The user complains about app performance - slow or lags, video or picture quality.	<i>Super slow and graphics dont update</i>
Privacy_Ethical	The user complains about privacy intrusion or ethical/legal issues.	<i>its invading are privacy they sending picture of products for sale in to are phone pictures and I always have to delete them from my phone picture . gopro is better</i>
Resource_Heavy	The user complains about CPU or memory usage.	<i>Embarassed at my Government. Consumes all cpu/ram, then freezes phone and tablet until the app crashes on both.</i>
Spam_Notification	The user complains about unwanted notifications.	<i>keeps sending false notifications</i>
UI (User_Interface)	The user complains about user interface (UI)	<i>Continuos UI error. Cleared cache and other actions.</i>
Update_Issues	The user complains about app malfunction after certain version updates.	<i>Since update does not work. Before that this app was great</i>
Uninformative	Either good review or bad abusive review but with no information useful to the developer.	<i>nice game (or) sucks.</i>
Uninteresting_Content	The user complains about the app being hyped too much but is a very simple app in reality with not much interesting content.	<i>Not worth the time to do download Completely worthless to plan a flight. Only tells me that Im CURRENTLY within 5 miles of an airport. I know that. Id like to research where I CAN fly without standing in that exact spot.</i>
Unresponsive	The user complains about app freezing or unresponsive.	<i>Freeze Aftet updating to v2.0.17 app stuck on startup page.</i>
Usability	The user complains that the app is confusing and hard to use.	<i>please.explain color codes..its difficult to make a decision</i>

### 3.2.2 Developer Reply Types

It is also essential to categorize the developer replies into their corresponding types to examine how and to what complaints developers respond to. The developer reply types are as described in Table 4: Provide Solution, Request Details, Solution in Progress Notification, Offer Direct Support, Solved Notification, Offer Refund, Others.

**Table 4: Developer Reply Types Description**

The Table provides the description and an example of each Developer Reply type

Developer Reply Type	Description	Example
Provide_Solution	The developer gives a solution for the user to try.	<i>Please update to v1.8.4 which should fix this issue - thank you!</i>
Request_Detail	The developer requests more details about the complaint issue.	<i>Which ones work and which do not?</i>
Solution_in_Progress_Notification	The developer notifies the user that a solution to the issue is in progress.	<i>We have reported this to our concerned teams and it would be soon fixed in our upcoming updates.</i>
Offer_Direct_Support	The developer provides an email or a contact or a website or forum where the user can seek help.	<i>Please contact support@dronedeploy.com in order to let us help you figure out the connection issues.</i>
Solved_Notification	The developer informs that the issue has been solved.	<i>Thank you very much for your patience Ron! We are happy to report that the issue has been resolved. Thank you again for taking the time to fly safe!</i>
Offer_Refund	The developer offers a refund as a means of compromise to a dissatisfied customer.	<i>Please send me your transaction id via email. Ill refund it.</i>
Others	The developer reply type which does not fall under the above-mentioned categories.	<i>Sorry you feel that way. What would you recommend?</i>



### 3.2.3 Technologies

In this section, the various technologies employed to build the framework of data collection are described as illustrated in Figure 13. Node JS scripts to scrape the Google Play Store were created and then the scripts were run using Python. An example of the Node JS script used for drone apps collection, app metadata and review data scraping are provided in Figure 14, Figure 15 and Figure 16. The results were again formatted to dictionary datatype and then stored into MySQL Database.



**Figure 13: Technologies**

The Figure depicts all the technologies employed in the thesis.

```
const util = require('util');
var gplay = require('google-play-scraper');
gplay.search({term: 'drone', num: 250, price: 'all'}).then((results) => results.map((value) => console.log(value)));
```

```
{ title: 'UAV Forecast for DJI Quadcopter & UAV Drone Pilots',
  appId: 'com.uavforecast',
  url:
    'https://play.google.com/store/apps/details?id=com.uavforecast',
  icon:
    'https://lh3.googleusercontent.com/yES2ghnL9PeRl2P00zFFiCRr-G4Omo_ra5gkqHu8V_wOy5YdbWSRwCHQN59jAFs3zEw',
  developer: 'Good To Forecast',
  developerId: 'Good+To+Forecast',
  priceText: 'FREE',
  free: true,
  summary:
    'Weather, GPS satellites, solar activity (Kp), No-Fly Zones and FAA TFRs',
  scoreText: '4.5',
  score: 4.473251 }
```

**Figure 14: Drone App Collection**

Example of Node JS script for Drone Apps Collection

```
var gplay = require('google-play-scraper');
gplay.app({appId: 'dji.go.v4'}).then(console.log, console.log);
```

```
{ title: 'DJI GO 4--For drones since P4',
  description:
    'Capture the world from above. DJI GO 4.0 has been optimized for all of DJI\'s latest products. These include the Phantom 4,Mavic Pro, Phantom 4 Pro, and Inspire 2. It provides near real-time image transmission and camera settings adjustment, as well as editing and sharing of aerial imagery.\n\nFeatures:\n\nAll-new Homepage and UI\nNear Real-time HD Image Transmission\nCamera Settings Adjustment\nUpdated playback interface\nUpdated Editor with improved UI\nMore templates and music tracks in Editor\nConvenient video downloading, editing and sharing\nIntegrated live streaming\nNear real-time flight data recording',
  descriptionHTML:
    'Capture the world from above. DJI GO 4.0 has been optimized for all of DJI\'s latest products. These include the Phantom 4,Mavic Pro, Phantom 4 Pro, and Inspire 2. It provides near real-time image transmission and camera settings adjustment, as well as editing and sharing of aerial imagery.<br>Features:<br>All-new Homepage and UI<br>Near Real-time HD Image Transmission<br>Camera Settings Adjustment<br>Updated playback interface<br>Updated Editor with improved UI<br>More templates and music tracks in Editor<br>Convenient video downloading, editing and sharing<br>Integrated live streaming <br>Near real-time flight data recording',
  summary:
    'Redesigned DJI GO 4 for Phantom 4,Mavic Pro,Phantom 4 Pro,Inspire 2 and Spark.',
  installs: '1,000,000+',
  minInstalls: 1000000,
  score: 3.8225107,
  scoreText: '3.8',
  ratings: 46646,
  reviews: 28180,
  histogram: { '1': 9107, '2': 2019, '3': 3089, '4': 6259, '5': 26170 },
  price: 0,
  free: true,
  currency: 'USD',
  priceText: 'Free',
  offersIAP: false,
  size: '94M',
  androidVersion: '5.0',
  androidVersionText: '5.0 and up',
```

**Figure 15: App Details Extraction**

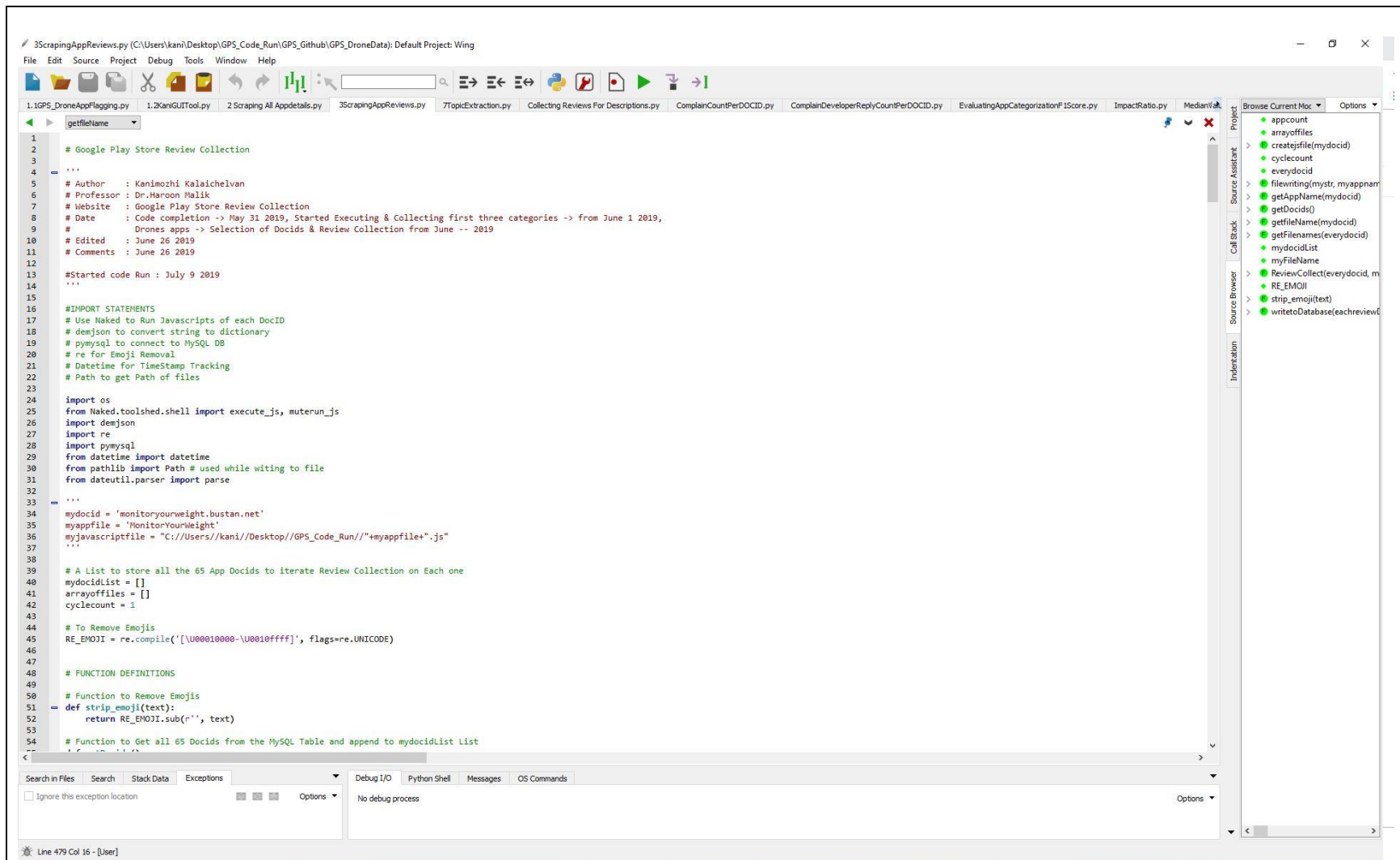
Exampe of Node JS script for App Data Extraction

```
const util = require('util');
var gplay = require('google-play-scraper');
gplay.search({term: 'drone',num: 250, price: 'all'}).then((results) => results.map((value) => console.log(value)));
```

```
{ id:
  'gp:AOqpTOGviz-XTN16kpbrADo-hYXqxfqF97fXkjwm2sdf3Xexpb85ETTaeDw8PY3rqB1BdSRYs90Z4QgoFFI9NQ',
  userName: 'Gord Piper',
  userImage:
    'https://lh3.googleusercontent.com/a-/AAuE7mCFMpZajOsNt9KmiRJouhEEQxLaVePhH8Y58IBI',
  date: 'Thu Jul 19 2018 16:10:49 GMT-0400 (Eastern Daylight Time)',
  score: 5,
  scoreText: '5',
  url:
    'https://play.google.com/store/apps/details?id=com.rvzerobotics.tello&reviewId=gp:AOqpTOGviz-XTN16kpbrADo-hYXqxfqF97fXkjwm2sdf3Xexpb85ETTaeDw8PY3rqB1BdSRYs90Z4QgoFFI9NQ',
  title: null,
  text:
    'Works flawlessly on my S8 with T1 remote. Works on my Note 4 as well but it \ndrops the BT connection to the T1 remote. This was scary as app doesn\'t \ngive phone control back until you turn off the T1. Found out the hard way \nas my Tello landed in a creek. An hour in the oven and all good.',
  replyDate: null,
  replyText: null,
  version: '1.2.10.19',
  thumbsUp: 1,
  criterias: [ [Object], [Object], [Object] ] },
```

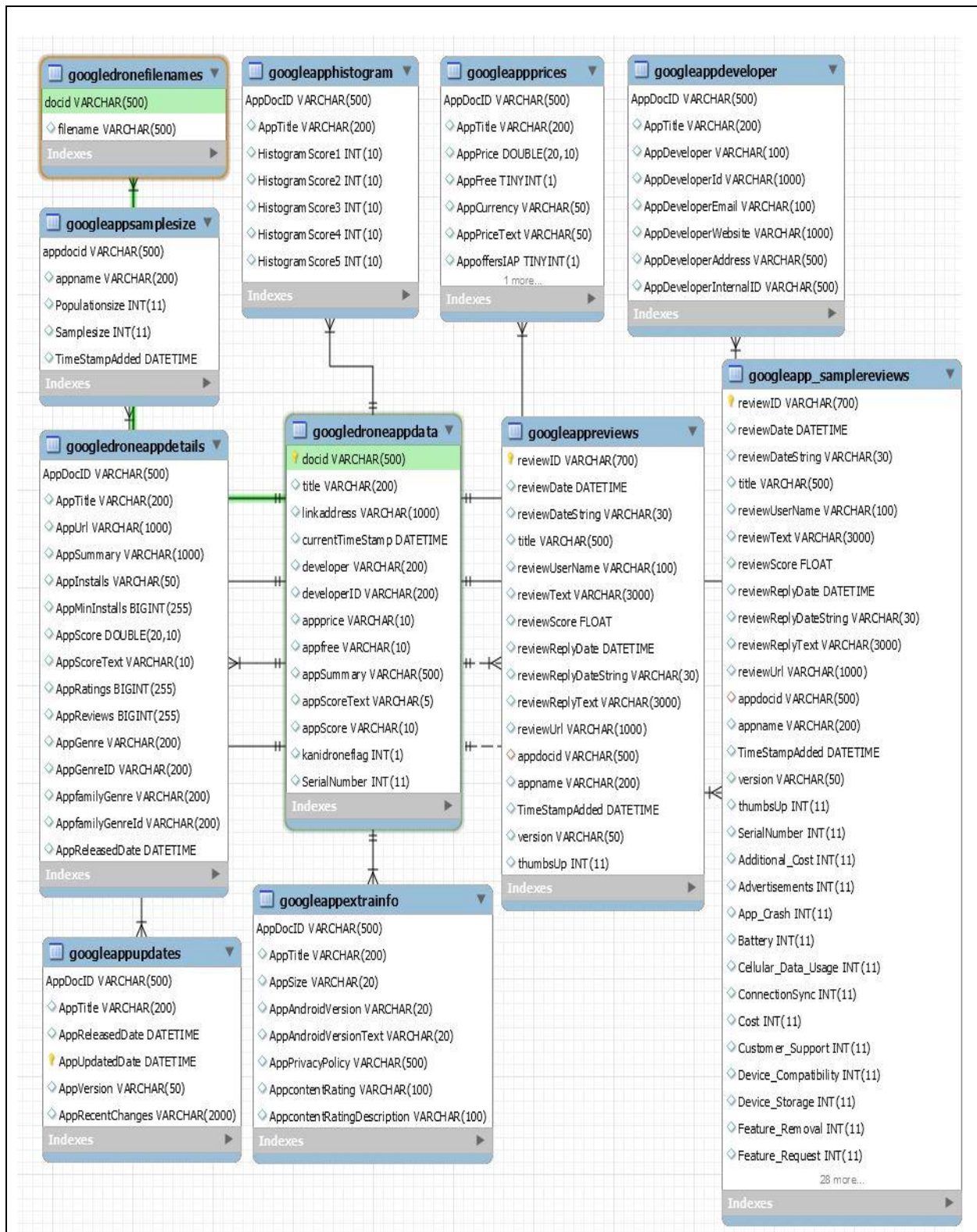
**Figure 16: Review & Developer Reply Extraction**

Exampe of Node JS script for Reviews & Developer Relpies Extraction



**Figure 17: Python Code Example**

The Figure provides an example python code used for reviews and developer reply scraping



**Figure 18: MySQL Database Schema**

The Figure illustrates the Schema of MySQL Database used to store all the Data collected from the Google Play Store.

The python codes were used for data collection, storage and analysis as illustrated in Figure 17 and the database schema developed to store all the app information such as metadata, reviews and developer replies is depicted in Figure 18.

### **3.3 Review & Developer Reply Classification**

This thesis on UAV/Drone app reviews and replies of the Google Play Store will assist the app developers in improving the quality and performance of the apps since they can comprehend the components of the app that require instantaneous refinement from the frequent user complaints. It will also be beneficial to drone enthusiasts to become aware of and to select from the wide variety of apps analyzed and also the features and functionality that they have to look for in a good drone app. Some of the developer replies to the user reviews mention that the issue faced by the drone app user was due to a fault of the drone firmware and not related to the mobile app. Hence this thesis study besides being beneficial to drone app developers in improving their apps will also aid the drone industry in updating their firmware in response to the expectations of the drone operators and enthusiasts.

A review can range from being most useful to a developer such as an innovative idea for a feature request or can be futile such as it can contain only curse words when an app does not work for them. Another important thing to consider is that a review can be about more than one issue. Hence to facilitate manual classification of the reviews into the defined complaint types, a GUI tool was created. Using this GUI shown in Figure 19, the grading person selected the complaint types each review falls into. Similarly, the developer replies were also categorized into 7 categories namely, Provide\_Solution, Request\_Detail, Solution\_in\_Progress\_Notification, Offer\_Direct\_Support, Solved\_Notification, Offer\_Refund, Others. A screenshot of the GUI tool created for the developer reply is given in Figure 20.

tk

☐ Additional\_Cost
 ☐ Advertisements
 ☒ AppCrash

☐ Battery
 ☐ Cellular\_Data\_Usage
 ☒ Connection/Sync

☐ Cost
 ☐ Customer\_Support
 ☐ Device\_Compatibility

☐ Device\_Storage
 ☐ Feature\_Removal
 ☐ Feature\_Request

☐ Functional\_Error
 ☐ Installation\_Problems
 ☐ Lack\_of\_Functionality

☐ Missing\_Notification
 ☐ Network\_Problem
 ☐ Performance

☐ Privacy/Ethical
 ☐ Resource\_Heavy
 ☐ Spam\_Notification

☐ UI/Other
 ☐ Update/Version\_Issues
 ☐ Uninformative

☐ Uninteresting\_Content
 ☐ Unresponsive
 ☐ Usability

☐ Information\_Seeking
 ☐ Information\_Giving
 ☐ Problem\_Discovery

**Google Play Store - App Review Categorization**

Data Number : 792

App DocID : com.spinmaster.airhogs.ARquad01  
 App Title : AirHogsConnectMissionDrone\_1303  
 Review Date : January 22, 2019      User Name : rdtgqasfv1432675 mqrdesfghbhuj65134575  
 Review Score : 1.0      App Version : null      ThumbsUp Count : null

App Review :

It wont let me connect and it just keeps crashing.

Add Extra Comments :

connect, crash

Previous

Submit

Next

**Figure 19: Review Classification GUI**

The figure displays the GUI developed to facilitate manual categorization of User Reviews into their corresponding Complaint Types. There are 27 total Complaint Types for User Reviews.



tk

☐ Provide\_Solution

☒ Request\_Detail

☐ Solution\_in\_Progress\_Notification

☐ Offer\_Direct\_Support

☐ Solved\_Notification

☐ Offer\_Refund

☐ Others

Data Number : 186

App DocID : com.dronedeploy.beta

App Title : DroneDeployMappingforDJI\_419

User Name : blake mcgowan

App Version : null

Review Score : 1.0

ThumbsUpCount :

Reply Date : July 12, 2018

Review Date : July 11, 2018

Developer Reply :

Add Extra Comments :

Submit

Next

Google Play Store - Developer Reply Categorization

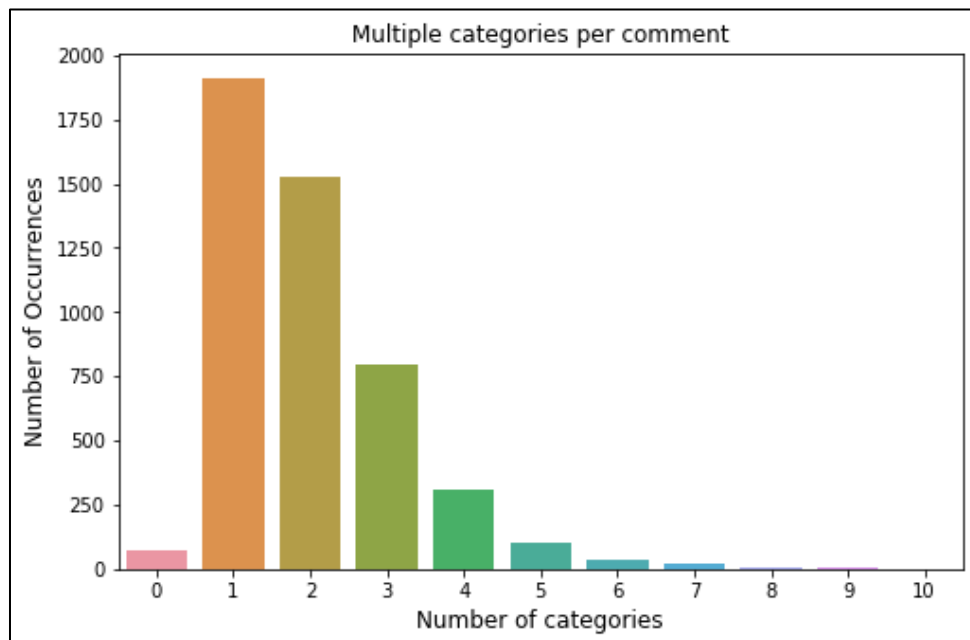
Hi Blake, what type of drone are you using? Is it listed on our page of Supported Drones?  
<https://support.dronedeploy.com/docs/supported-drones>

Wont connect to drone

**Figure 20: Developer Reply Categorization GUI**

The figure displays the GUI developed to facilitate manual categorization of Developer Replies into their corresponding Complaint Types. There are 7 total Developer Reply types.

The Histogram of Complaints with multiple labels is depicted in Figure 21. The “0” category is the feedback that does not fall into any of the 27 categories. They belong to the “Others” category. Although it is clear from the graph that the comments with a single label dominate over others, the number of feedbacks with two labels are nearly equal to the single label comments. There are no comments with more than 10 labels associated with it, even though the total number of labels or categories is 27.



**Figure 21: Number of Complaint Types per User Review**

The graph illustrates the distribution of multi-labels across the manually categorized review dataset. It is clear from the graph that even though the single labeled data dominates over the rest, it is closely followed by the number of reviews with 2-labels.



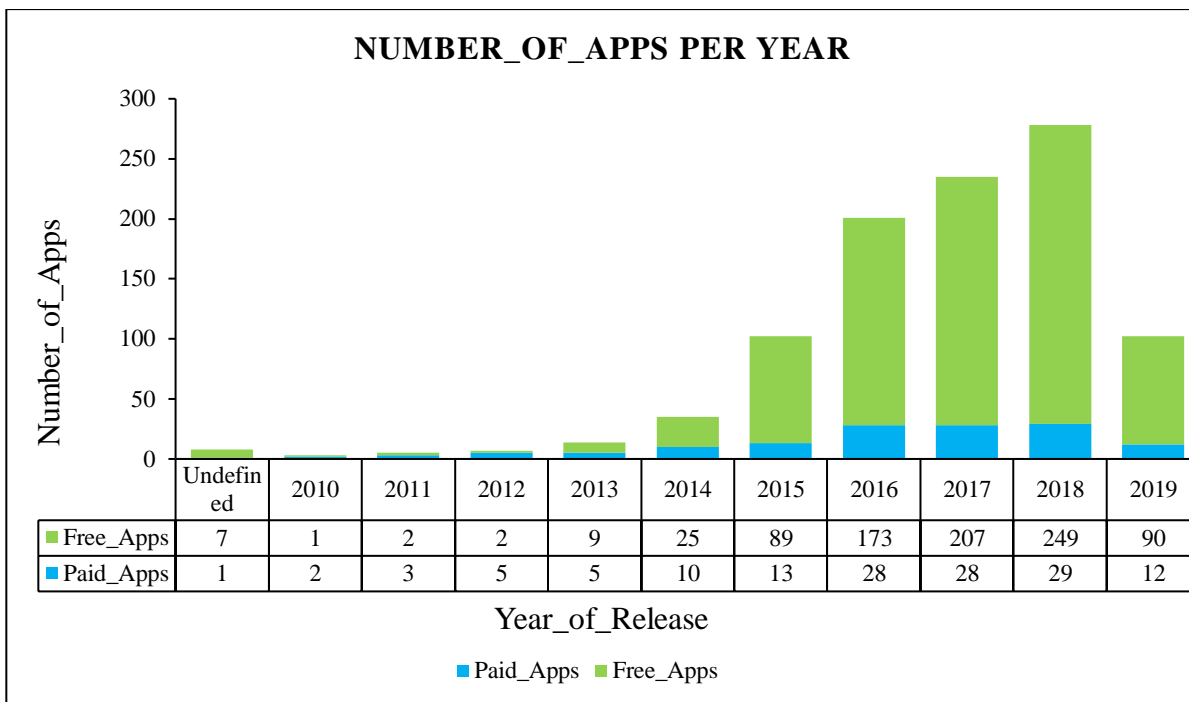
## CHAPTER 4

### STATISTICS

#### 4.1 Drone App Exploratory Analytics

##### 4.1.1 Drone Apps Evolution

Out of the 970 drone-related apps, 8 apps did not have release date data. So, on analysis of 962 apps, the number of drone or UAV apps seems to have steadily increased over the years as shown in Figure 22. Also, initially in 2010 and 2011 the number of paid apps was slightly higher than the number of free apps, which changed drastically since the year 2013. The number of free apps released per year has reached a peak in 2018 with 249 free drone-related apps and 29 paid apps which occupies 25.6% of the total 970 drone-related apps (the dataset of total drone-related apps in the Google Play Store till date – 2010 to 2019). The number of drone-related apps was remarkably highest in the years 2017 (232 apps) and 2018 (274 apps).

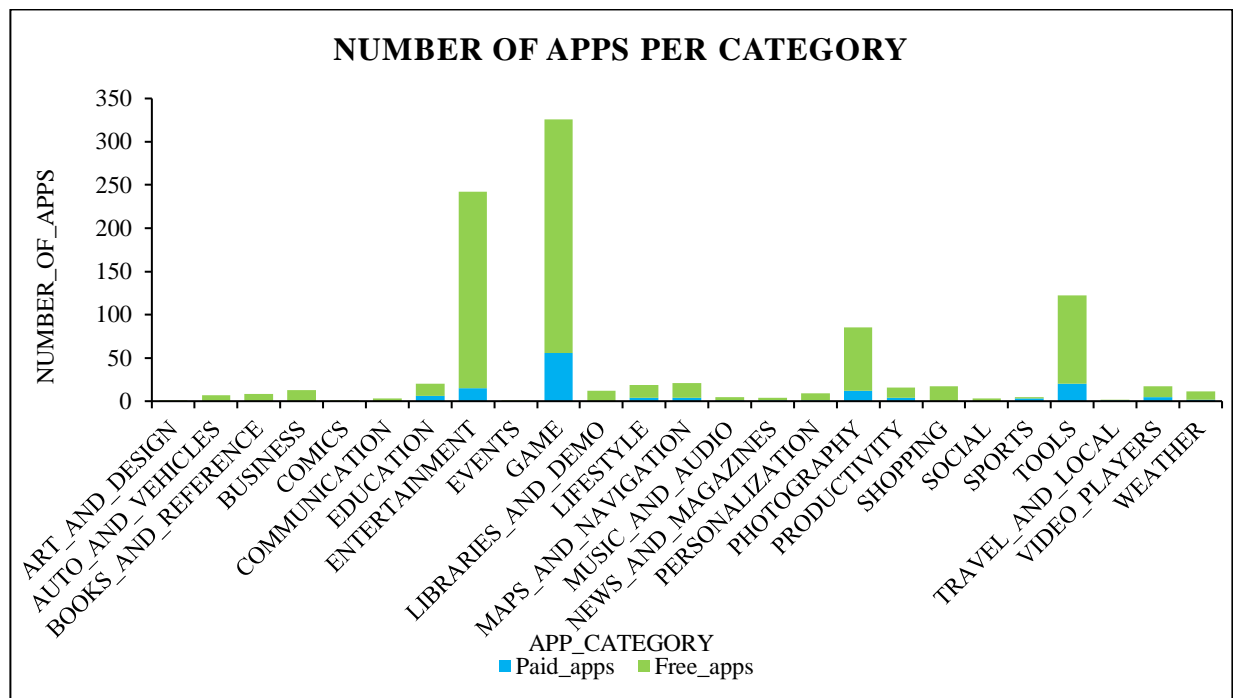


**Figure 22: Drone App Evolution**

The graph displays the growth in the number of drone-related apps over the decade.

### 4.1.2 Drone App Categorical Analytics

Out of 970 apps, apps fall under 25 categories of the Google Play Store's explicitly defined 35 categories. As can be seen in Figure 23 most of the drone apps fall under Games, Entertainment and Tools categories. Apart from the above mentioned three categories, which were apps related to drone games or drone controller or drone simulation apps, drone supporting apps were found in the Photography category. The Shopping category contained apps such as 'Drone Store' where users can buy drones at the lowest price online, get discount coupons for drones & drone products and also get a stream of aerial photos from around the world, view tutorials for DJI products and get to know about global events. Weather category contained apps to help users determine ideal conditions before flying a drone outdoors. For example, an App titled 'UAV Forecast for DJIQuadcopter UAV DronePilots' helps users view the weather forecasts, GPS satellites, solar activity, No-Fly Zones, and flight restrictions.



**Figure 23: Drone App Categorical Analytics**

The graph displays the distribution of the drone-related apps across 25 categories.

#### 4.1.3 Drone App Developer Centric Analytics

**Table 5: Top Developers of Drone Apps**

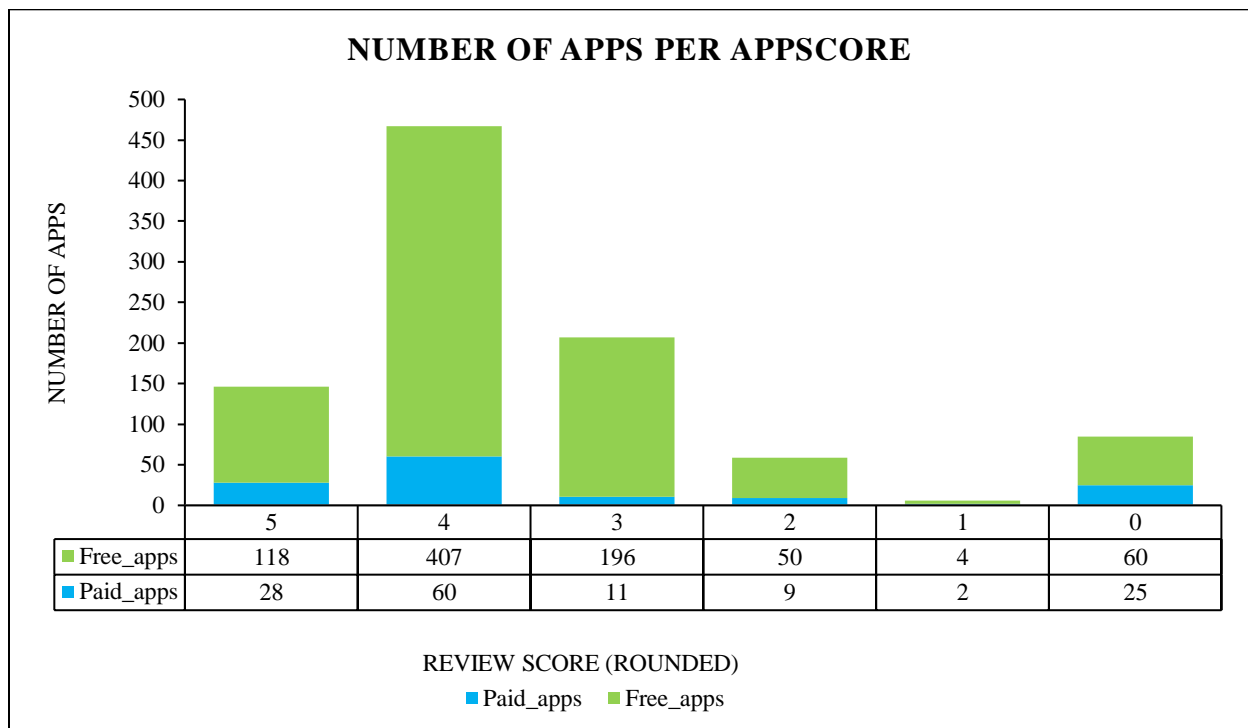
The table lists the topmost developers of drone-related apps in terms of quantity (number of apps per developer)

Developer	Paid_apps	Free_apps	No_of_Apps
MARK mai	0	30	30
SteveChan	0	22	22
FYD Technology Co., Ltd	0	21	21
Zheng Xiang	0	17	17
GuanZhi Technology Inc.	0	15	15
HFun	0	14	14
steven liu	0	14	14
Vison Electronics Technology LTD.	0	9	9
SYMA	0	9	9
logic	0	8	8
TrimcoGames	0	8	8
Cheshire Creative Labs	2	4	6
Parrot SA	0	6	6
Merlin Digital	0	6	6
Rooftop Group USA Inc.	0	6	6
DronePilots Network	0	6	6
GuanZhi Technology	0	6	6
Brookstone Innovation	0	5	5
ZET	4	1	5
Skyrocket, LLC	0	5	5
Pix4D	0	5	5
Guangdong Meijiixin Innovative Technology Co., Ltd	0	5	5
睿兴实业	0	5	5
Reference Mobile Apps	0	5	5
Hi-Tech Optoelectronics Co.,Ltd	0	5	5
DPI Inc.	0	5	5
Protocol	0	5	5
Abrim Enterprises Inc.	0	5	5
Udirc Toys Industrial Co., Ltd	0	4	4
Forever.eu	0	4	4
cfans	0	4	4
DJI TECHNOLOGY CO., LTD	0	4	4

The major developers of the Google Play Store drone apps are listed in Table 5. An important thing to be noted is all the major developer's apps were available for 'free.' Also, from the table, it is clear that the top manufacturer may not necessarily be manufacturing a greater number of apps. The top manufacturers may be quantitative in number. But the Qualitative manufacturers like DJI (4 apps), Parrot (6 apps), Yuneec (4 apps) may have produced only a few apps (all are free apps) but have proved to rule the industry by their quality of drones and apps.

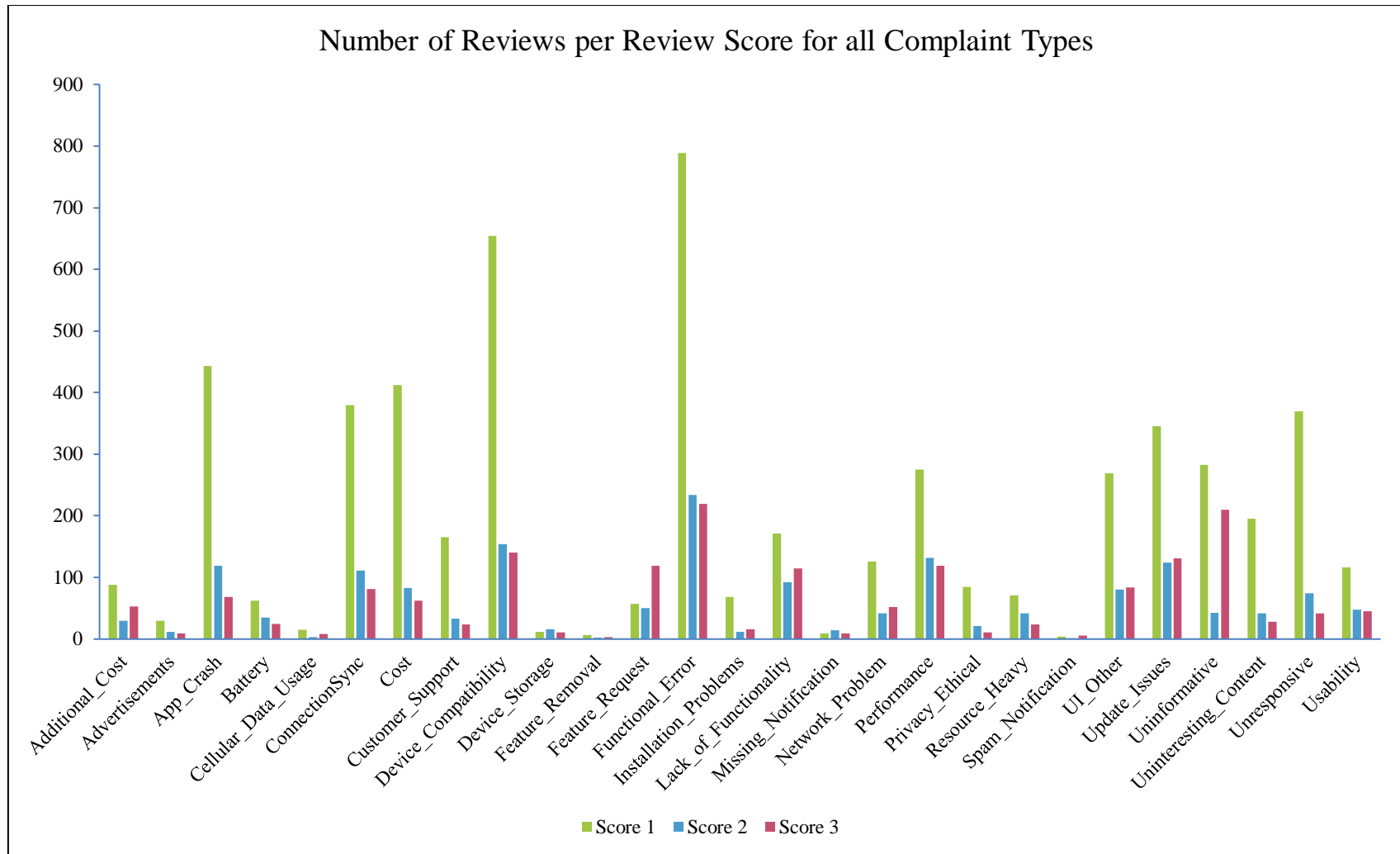
#### 4.1.4 Drone App Score Centric Analytics

The thesis also studied whether the majority of apps scored low ratings or high ratings. As can be seen in Figure 24, most of the apps' score was 4 on average. The apps which have been rated with a score of 5 had very smaller number of installs and hence can be considered to be biased. The apps with more installs have an average overall rating of 4.



**Figure 24: Number of Apps per AppScore**

The graph depicts the distribution of apps based on the appscore. Appscore ranges from 0 to 5.



**Figure 25: Reviews Distribution per ReviewScore**

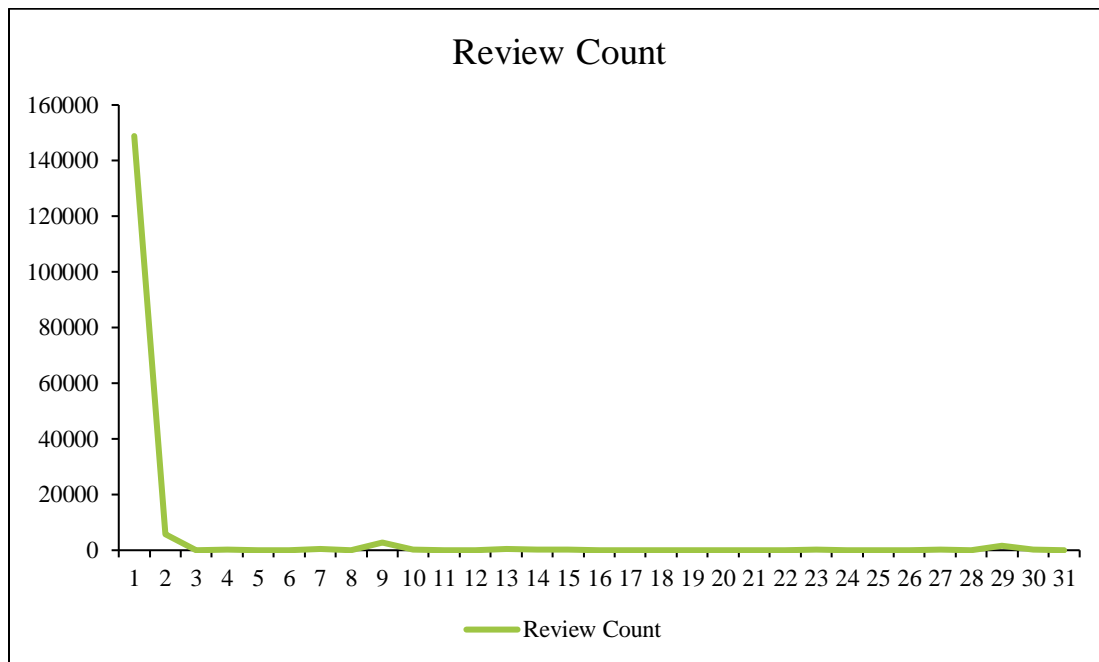
The graph illustrates an in-depth analysis of review distribution at review score level, which is found to be consistent with the overall review distribution.

#### 4.1.5 Reviews Distribution per ReviewScore

After manual categorization of the reviews, the distribution of the reviews among the review scores for all the 27 complaint types was analyzed, which is illustrated in Figure 25. Since the thesis aims to only analyze negative feedback or complaints, the categorized dataset comprises only 1-star, 2-star and 3-star rated review comments. It is clear from the graph that the number of reviews or the percentage of reviews with 1-star rating dominates in quantity regardless of the complaint type. In very rare cases such as Feature Request, Lack of Functionality and Uninformative complaint types the reviews with 3-star rating dominate over the 2-star category.

In the case of the Uninformative complaint type, the 3-star rating count dominated because this type contains both appreciating as well as abusive reviews and the app users gave positive comments in this category's 3-star feedbacks.

#### 4.1.6 Reviews Distribution per App Price



**Figure 26: Review Count per App price**

The graph displays the review distribution according to the cost of the apps

As can be seen from Figure 26, the number of reviews decreases as the price of the app increases. This consequence is because the number of apps decreases rapidly as the price increases. There are only a handful of paid apps when compared to the number of free apps and less so high-priced apps.

## CHAPTER 5

### RESULTS & EVALUATION

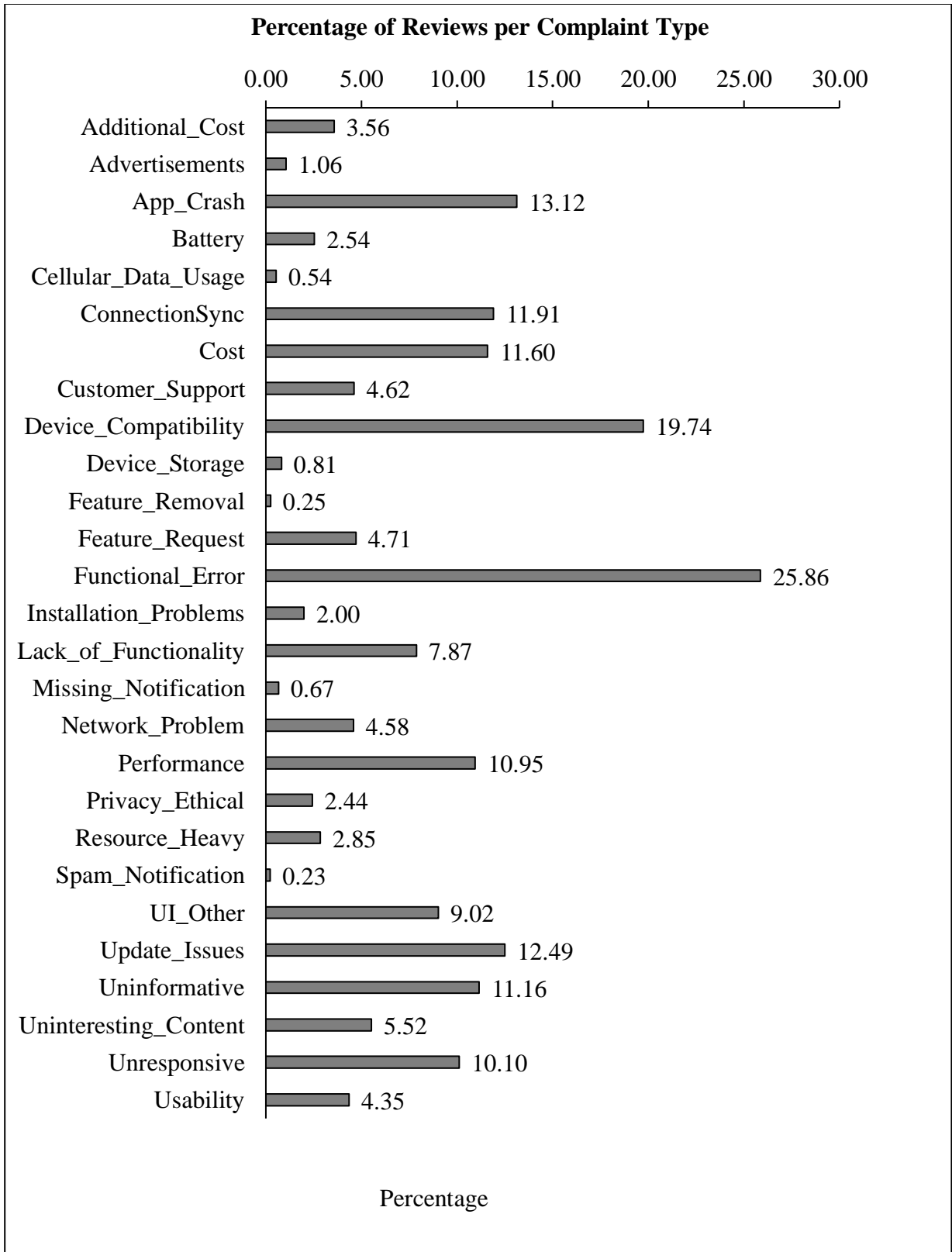
**Table 6: Percentage of Reviews per Complaint Type**

The table displays the distribution of reviews across the defined 27 complaint types.

Complaint Type	Number of Reviews per Complaint Type	Percentage
Additional_Cost	171	3.56
Advertisements	51	1.06
App_Crash	630	13.12
Battery	122	2.54
Cellular_Data_Usage	26	0.54
ConnectionSync	572	11.91
Cost	557	11.60
Customer_Support	222	4.62
Device_Compatibility	948	19.74
Device_Storage	39	0.81
Feature_Removal	12	0.25
Feature_Request	226	4.71
Functional_Error	1242	25.86
Installation_Problems	96	2.00
Lack_of_Functionality	378	7.87
Missing_Notification	32	0.67
Network_Problem	220	4.58
Performance	526	10.95
Privacy_Ethical	117	2.44
Resource_Heavy	137	2.85
Spam_Notification	11	0.23
UI	433	9.02
Update_Issues	600	12.49
Uninformative	536	11.16
Uninteresting_Content	265	5.52
Unresponsive	485	10.10
Usability	209	4.35

The percentage of user reviews in each review complaint type is depicted in Figure 27.





**Figure 27: Percentage of User review per Complaint type**

The Figure displays the percentage of reviews across the defined 27 complaint types.

After all the reviews in the sample size dataset were categorized into their respective complaint types, the results were examined. Both the user reviews as well as the developers' replies were analyzed. The percentage of reviews in each review complaint type is listed in Table 6. Thus, it can be seen from the table that the most frequent complaints are Functional Errors, Device Compatibility, App Crash, Update Issues, and Connection/Sync Issues. The least frequent problems are Cellular Data Usage, Feature Removal, and Spam Notification. A summary of the reviews in each complaint type is provided in the below section. Since the thesis concentrates on what users complain about regarding drone apps of the Google Play Store, only the low rated reviews are analyzed.

## **5.1 Additional Cost**

This complaint type occurred mostly in the drone-related game apps. Additional cost encompasses cost to suppress the unnecessary ads, in-app purchases, cost for vital features, forced upgrades and unadvertised content.

### **5.1.1 Pay to Remove ADS**

Most of the users complain that even if the game is marked as free, people are forced to sit through the occasional ad for a different game thus stealing a share of the user screen time. The user typically does not like to pay for apps if there is a free alternative, but developers still need reliable avenues for generating revenues. Including ads into the drone, the game app offers a workable compromise wherein users are conditioned to expect the occasional ad interruptions in exchange for not having to deal with upfront costs.

*“All they want is for you to spend money, as if they didnt make enough with all the adds. They steal your gems, weekend tournament is always under maintenance... this people are truly thieves, too bad because they could have so many more players. THIEVES!!!!”*

### 5.1.2 In-App Purchases

The user also complains about another *dimension* of additional cost i.e., *In-app purchases* without prior notification or mention in the drone app description. An in-app purchase is any fee (beyond the initial cost of downloading the app, if there is one) an app may ask for. Many in-app purchases are optional, giving users additional features while others serve as subscriptions and require users to sign up and pay a fee to use the app, often after an initial free trial. The users grumble that developers are monetizing their free apps by forcing an in-app purchase. Customers complaining often mention that the app is free initially but later has too many in-app purchases which make it a “pay to win” type of game.

*“Nah... Doesnt do anything that other free apps dont and makes you pay for additional features. And the refund didnt work for me... UPDATE: I still dont see how this is superior to PS or other editors. And I hate in-app-purchases. You scam people into spending more **when you offer the app for 0.10 and ask for more in-app.**”*

*“Free but 10€...”*

*“The app itself is very good. The reason I only give it three stars is the unscrupulous way it is advertise. The app is fairly expensive at \$29.99, but wait if you want mission planning and Geotaging you have to pay an additional \$30.00. **They dont tell you this in the video or the published literature.** I would have to say that is dirty business practice to lure you in and then punch you in the gut. SidePilot for Apple is just as good, not quit as pretty, but it sells for \$12.99 and works really”*

*“**Unreasonable** in app purchase Thanks for your great app. Unfortunately its not good to buy an app and again pay for in app purchase. It should be free with in app purchase or or not free to pay once. I hope you consider this point.”*

*“its impossible to pass Rat Trap mission **if you dont buy extra stuff**. This game should be playable without buying anything.”*

*“**this game is a money taking game** its a HORRIBLE game nobody should play this...”*

*“Was a great app, **but being asked to pay for it again**, so I star as Im not paying twice”*

### **5.1.3 Additional Cost for Vital Features**

A few users complain of the app charging money for some obvious and much-needed features in the drone app.

*“Purchase to save? So after reading the description I thought, sounds good lots of algorithms so it must have some fancy features. Nope every screen is manually adjusted. Spent a good few minutes on one photo and whats this? **No save button**. Nope, thats an in app purchase..just to save... I also see the developer is having a go at the customer base who complain about being deceived. its clearly listed the purchases in the description no its not mate... The only mention of purchases is the Google play store stats page.”*

*“Parrot got em big head now I love you guys but come on. A hundred plus for a micro mini drone and you want to **tack on another \$20 for Flight Plan? Or worse \$500+ for the Bebop and still you want \$20 for Flight Plan... Seriously...?** Worse, the thing has issues connecting, not just with my cell(s) but others that have tried and many others as reviewed on your board. Hate to say it but, Parrots obviously got the big head. Size it down and humble yourselves. Because, yeah, well walk to another over being nickel dimed for everything.*

*“Everything important (widget metar, runway x-wind) **must pay other apps provide for free**”*

### **5.1.4 Forced Up-Grade**

Many of the customers complain of shabby functionalities of drone apps that need a paid upgrade for smooth functioning of the drone app.

*“Cant get app to connect to my phantom 4 pro. Have done everything, and I mean everything, recommended to connect using an android tablet. Ive just spent the better part of 2 hours turning defaults off, plugging and unplugging usb, restarting apps, tablets, controllers and everything imaginable. **App wants me to upgrade for better support.** I wont spend a dime if I cant get the app to work first.”*

*“**upgrades are slow** without **spending** real money.”*

Whereas, a few users complained that the app forced them to buy a premium version after a period of time or pay extra money to be used with specific drone brands.

*“**they force you** to but premium after a bit of time.”*

*“Lock to certain make: It says in app purchase but its right off the bat. **9.99 to use it on dji phantom 3. That sucks**”*

Many users have expressed their concerns about not getting the refund for an accidental in-app purchase or being charged an additional fee for an upgrade which was not much different from the previous version.

*“bought an upgrade **didnt receive the upgrade.** give me my 14.99 back”*

*“Nah... Doesnt do anything that other free apps dont and makes you pay for additional features. And the **refund didnt work** for me... UPDATE: I still dont see how this is superior to PS or other editors. And I hate in-app-purchases. You scam people into spending more when you offer the app for 0.10 and ask for more in-app.”*

In some cases, after reinstalling, the user is asked to pay again for the app which was already purchased.

*“Im being asked to repurchase the app. I had purchased the app last year. After having used it for some time, I had to uninstall it to free up space. Now when Im trying to reinstall the app, Im*

*being asked to pay again. Ive even mailed the developer about it but havent received any response yet.”*

## **5.2 Advertisements**

This category of complaints occurs mostly in gaming apps. Generally, users do not like to waste time seeing ads. Most of the users complain that the ads displayed during the drone games are too many and continue even after buying an in-app purchase to remove it.

### **5.2.1 Too Many Ads**

Drone app users complain about the numerous annoying ads cluttering the app in the middle of a game in case of gaming apps, or during operational tasks in case of controller apps. Users find it annoying since it steals a share of the user screen time, as well as these ads are displayed during a crucial time in a game or a drone control, which spoils their app experience.

*“To many ads, always want you to spend money”*

*“Fun but way too many ads”*

*“Ok This app is good but too many ads”*

*“The ads are annoying”*

*“The game is addictive but not good. Irritating adds. Game play is very one dimensional and quickly loses ability to hold your attention. Limited weapon types. irritating adds which seem to popup just before pressing a button really ruins the experience.”*

### **5.2.2 Watch Ads to Win Prizes or Unlock Features**

Users state that they watch the ads featured to earn any prize such as gold or gems rewards in case of game apps or to unlock new features for non-game apps. While a few users complain that it is hard to get the gems even through watching ads, which means the game leads to a “pay to win” style, others also complain that they lose game progress and therefore, the

game gems and gold too due to some functional errors.

*“it says you can **watch an add to win one prize** out of maybe six different prizes but it gives you a puzzle piece EVERY time. (im glad they cant even respond to that)”*

*“Been watching **every ad for the free gems**. Collected 121, stopped playing for 30 minutes and came back to only 9 gems. Didnt use any. Where did they go???”*

*“Decent game, but it keeps taking your gems. Literally havent spent any gems. Had 131, **watched an ad to get 5 and a gold bonus**, and then I had 9 gems. Everytime I watch a new ad, or load up my game anew, my gems magically disappear.”*

*“The game was fun in the beginning, but as you progress further on it becomes almost impossible to beat the aliens cause you dont get enough gold or gems to upgrade your spaceship. Its ridiculously **hard to get gold and gems**, even when you watch a whole bunch of ads. The game is pay to win”*

### **5.2.3 Ads after New Update or Forced Ads**

Some users have also commented that the ads appeared only after the new update and the users have demoted the app from a 5-star rating to a 1-star rating due to this reason, which would affect the overall average rating of the app.

*“Love the game. **HATE the update. Tons of Ads**. After every mission you have to watch a Ad.”*

*“Invested many \$ into your game. Previously 5 stars, but now **NEGATIVE 1** with **new update**. No new regions and game **automatically goes to stupid ad**. Takes several attempts to back out. Tried restarting, uninstall/reinstall to no avail. Not spending another penny nor installing any of your additional games until corruption is found and removed and new regions added.....then Im sure itll be a 5 star game again. And please dont answer with some stupid need more info response. Thanks”*

Few users state that they are being forced to watch the ads and hence users resort to such a level that they quit using the app. Due to this convention, users also abuse app developers as being greedy for money.

*“Stop forcing people to buy items and watching ads, im uninstalling because of this issue”*

*“Used to be fun, now they just **shove ads down your throat.**”*

*“JUST ANOTHER MONEY HUNGRY GAME THAT WILL SUCK U IN, **HAVE TO WATCH ADS TO GET ANYWHERE**”*

#### **5.2.4 False Advertisement**

Drone app users accuse some drone apps of false advertisement since the app is hyped in the advertisement videos while in reality, the app is not worthy enough or the update promises fixes to the prevailing bugs but fails to do so.

*“Parrot i think your company just committed **false advertisement with the last upgrade.** Its was supposed to fix bugs now im losing control of my drone after 50 feet. Either fix or i make a complaint to the FAA and Better Buisness Bureau. Consumers are protected by laws under both. Due to faulty upgrades, Parrot has put both drone operators as well as other civilians in danger from crashing drones. Hopefully you look at the issue before someone gets hurt!”*

*“**Why advertise Galaga when clearly its not!**”*

*“Video wont sync Get a solo drone or phantom, far too much money for something that **doesnt work as advertised.**”*

#### **5.3 App Crash**

App crashes occurred mostly in explicit drone apps. These include drone controller apps such as ‘Video\_Players,’ ‘Entertainment,’ ‘Photography’ & ‘Education.’ App crash may occur due to various reasons such as device incompatibility or update issues or network or connectivity



problems. Almost 13% of the complaints were about the app crash. The app crash causes the app to quit working or stop working thereby displaying an unresponsive screen to the mobile user. In some instances, users actually appreciated the features of the app and felt that they would have given a 5-star rating only if the app did not have crashing issues. Additionally, few cases reported that the app crash logs were also missing. (Developers sometimes ask for crash log to be sent for troubleshooting purposes since in these cases, it will be easier to find out the root cause with the aid of crash log data).

### 5.3.1 App Crashes on Open or Connect

Most complaints were of the app crashing immediately on the app startup or while trying to connect to the drone. In some of the cases, the app crashes during midflight, and the user loses control of the app, thus unable to land it safely, causing the drone to drift off, crash and fall, which damages the costly drone, which leads to extreme user dissatisfaction with the drone app.

*“Constantly **crashing at boot** on my google pixel 1 using Android 10. Completely unusable, I used to love this app.”*

*“**Keeps closing when i open it.**”*

*“This **app crashes before it starts** on my Droid Maxx and both my Android tablet. Very disappointed in buying something I cannot use.”*

*“Whenever i am trying to **open the game it is automatically crashes** due to which i am even not able to open this game on my asus fonepad 7. Tried the game once after so long but still facing the same issue which is mentioned below and already tried the steps mentioned in the reply but after that also it is not working.”*

App crashes on connecting to the drone may be due to updates or performance issues such as lag or network problems. In some cases, this was due to a lack of consistent support for a

few drone models.

*“Crashes everytime you try to connect to the drone. Dont buy.”*

*“It wont let me connect and it just keeps crashing.”*

*“I purchased this app ,but after connecting the easy cap it is closing automatically .I need refund. How can I fix this app?”*

### **5.3.2 Crash due to Device Incompatibility**

A certain number of drone app users mention that the drone app crashes, particularly on their device (for particular hardware or OS). While some of the crashes were due to Android OS (or its various versions), others were due to hardware incompatibility. A handful of users were able to identify whether it is an OS or hardware incompatibility by testing it on different mobile phones or with different versions of Android OS.

*“Crashing in android 5! Unusable app.”*

*“Crash for my LG G5”*

*“Doesnt work with Android 10. Immediately crashes.”*

*“I had a Nexus phone and the app worked great but I got the essential phone and it crashes upon loading please dji fix this”*

### **5.3.3 Crash after an Update**

In some cases, an app update may have rendered the device incompatible, which highlights the need to regression test the app on different software platforms and versions as well as in all mobile phones (hardware) supported by the app. Some drone app users also mentioned that the update was a forced update. A few cases mentioned that the users have crash issues only with a particular version of the app and were unable to update it. In such cases, the users request an update that would fix these problems.

*“Crashes on app load since last update. (Oneplus 2)”*

*“Worked before the up date but now it just crashes right away”*

*“this app working great before 1.16 version updated. but since update, my app crash and cant use again. black screen app not responding every start app on my phone. i use phone ASUS ZE551ML 4GB RAM.”*

*“Continuously crashes after last update. Please fix. Crashes on Nexus 6P and Nexus tablet. Both with latest OS.”*

### **5.3.4 Trust & Reliability of the App**

Also, for the cases where the app crashed during mid-flight, it caused their drone to drift off without control (losing the drone) or hit and fall (damage). RTH(Return to Home) feature also fails sometimes. These crashes may cause physical damage to the costly drone. Hence users lose trust and tend to question the stability & reliability of the app. Users also abuse the app as being unusable. They also assure to improve their rating once the crash problem is fixed.

*“Constant crashing. **Can not trust** to operate expensive drone.”*

*“Continually crashes, super disappointed in the app, glad for fpv goggles so I could fly it back, u cant trust the app”*

*“Unreliable. Crashes alot, most recently at 400ft. Stick with gji go. Emailed twice now for a refund. No response yet.”*

*“Crashes constantly and almost lost my drone, **needs to get more reliable**. Worked better 1 year ago that it does today...”*

*“Doesnt work. App quits wont connect. Tried everything. **Cant be trusted**. Waste of money.”*

## 5.4 Battery

Customers complain about their “mobile battery” being drained very soon when using the drone app. They also specify that the app has some services that run in the background even after closing the app, which may have consumed more battery. On the other hand, a few users complain about “drone battery” problems. They mention that the drone battery was fully charged but drops immediately to a dangerously low level as soon as the drone takes off.

### 5.4.1 Phone Battery Drain due to Background processes

The mobile phone battery drains due to the drone app’s processes or services running in the background even after the user closes the app. In some cases, the user accuses the app of using a lot of mobile data to send information to the server, though the user is not aware of what data is being transmitted. A few users mention that they have to keep uninstalling and installing the app to prevent the battery drain.

*“Had to uninstall this. It **uses 40% of my phones battery even when not in use.** What the heck is it doing in the background all day?”*

*“Old app was way more stable and faster. DJI Go 4 also keeps **draining my phone battery** when Im not using g it, it also sends a lot of mobile data, I wonder which data is beeing sent to the DJI server... Using a Sony Z1C (Cyanogenmod 12.1) with a Mavic.”*

*“This app is **TERRIBLE**. For the most part, it works but aside from when it crashes, it also runs software in the background after you quit it and **SUCKS THE BATTERY HARD!** Ate up my full battery in 3 hours. You need to check the applications manager to force quit these running background DJI apps. Who knows what they are actually doing?”*

*“**App runs in the background and sucks your battery** as well as phone performance even when your hard close it...”*

### 5.4.2 Drone Battery Drain

Drone app users also complain about the drone's battery issues. They accuse that the battery drains quickly even before or immediately after the drone takes off.

*“Never buy this!! I followed instructions but The **battery drained before even taking off!!** I changed it at the store and the battery lasted longer: only 30 sec!! Save yourself trouble and dont buy the parrot Spider minidrone.”*

*“The drone its self is great but **battery drains** super quick it charges for like 30 min and dies in 10 min and this app is good I guess.”*

*“Rubbish My rolling spyders **battery is rubbish** parrot I recommend you take a good look at this because I can by a drone for half the price and it will be much better :(”*

*“Since updated **battery drain** shows level dropping 40% in 15secs have to land even though I know battery fully charged same with spare battery. Please fix cant use drone!!!”*

*“Fully charged **batteries drop to 40% immediately after take off.** App is a disaster. We dont need another social video app. We just need a remote for the drone.”*

### 5.4.3 Phone Heats up due to Battery Drain

A few drone app users complain that their mobile phone gets heated up due to app errors, which may be due to the battery drain caused by the services running in the background even after the user exits from the app. Users also mention that this problem leads to the app becoming slow and losing connection with the drone or could result in functionality failures that could be fatal. For e.g., if the RTH (Return to home) fails, it could cause physical damage to the expensive drone.

*“i have a nokia with anroid 8.0 and had hours of trouble connecting the thing after trying many thing recommend by dji themselves . then i get **warnings on the batteries that they overheated,***

*went got a refund do not recomend.”*

*“The current version keep continuously running in the background and **drain the battery plus it heats up the phone**. Ive just uninstalled it.”*

*“The app is great. after the last update and using it to fly several fields, my android and iPad **started heating up badly** to the point on slowing th app and not recognizing my drone controller. Please fix this issue.”*

*“After upgrade, it turned so terrible **Battery drains so fast, easy overheated**, EIS can stop automatically, and the most fatal is RTH can stop automatically Please fix it.... Upgrade must be better, not worse”*

#### **5.4.4 Battery Percentage Indicator**

Some drone app users mentioned that the app requires a battery indicator feature. In some cases, the feature had been removed in an update and the user demands for it to be added back.

*“Please increase Bluetooth gamepad compatibility, signal reliability and **bring back the percentage indicator on the battery!** App is fairly good but needs some more reliability.”*

*“**battery percentage indicator is needed**”*

*“couldnt get my S9 to connect to drone through app so had to use a different phone , thought there would of been a **battery indicator** and height indicator on app for drone otherwise you would of got 5 stars”*

*“**Add battery indicator** on this app so we can know the percentage of the drone during flight”*

*“**Needs a battery indicator...** Its hard to see the lights when flying during the day. Also a support for VR would be great. Other than that it works pretty well with my X5uw”*

## 5.5 Cellular Data

Only 0.54% of the complaints belong to this category. The users complain that the app sends a lot of mobile data in the background, though the users are not aware of what data is being communicated since it is out of control. A few others also mention the role played by mobile data in their drone app connectivity issues.

### 5.5.1 High Mobile Data Usage (Resource Heavy)

Some drone apps have services that run in the background even after the app is closed. In some cases, these services transmit data to the server without the knowledge of the mobile app user. Hence customers lament about their mobile data being overused.

*“It **wasted all my phone data**, it was the beggining of the month, how un the hell i will be without mobile data all the mont? WTH”*

*“Old app was way more stable and faster. DJI Go 4 also keeps draining my phone battery when Im not using g it, it **also sends a lot of mobile data**, I wonder which data is beeing sent to the DJI server... Using a Sony Z1C (Cyanogenmod 12.1) with a Mavic.”*

*“A very very excellent game but just the thing is it **need to reduce its data usage**”*

*“Crappiest company and zero support, app freezes, camera do not center, live feed have lines. Remote battery fails and they want to replace camera and remote at exorbitant cost instead of replacing faulty battery in remote and faulty camera. Both are well know bugs and issue.. they company should fix it as a general recall. **App kills cellular data with marketing and spying , drains the battery of phone and resources.** Havent seen any company as shocking as DJI! You pay top price to buy the drone and they give buggy product and S\$h1t.. #hg&@\*)(;? Support and app with Ads. Already paid so no advertisements needed! **Takes data off your phone**”*

### 5.5.2 Connectivity Issues

Most of the feedback related to cellular data was about connectivity issues. While a few users complain that they were unable to connect to the drone, most of them state that they also had connectivity issues, but the issue was solved immediately when the mobile data was turned off. Rare cases report that the issue persists even after switching off mobile data.

*“Works. Initially had problems connecting to the drones network but **disabling mobile data fixed the issue.**”*

*“Was really frustrated that I couldnt get it to work until I seen a review that said to **turn off your mobile Data! Viola! Works like a charm!** Distance varies with device of course, but you could use a mesh net/ repeater in some areas.”*

*“UPDATED: App crash appears to have **resolved after starting it with wifi and mobile data disabled.** Would have appreciated if the zoom function from Gimbal button was smoother. Right now its quite jerky. Video appears quite jerky when panning, with my native camera its super smooth. Couldnt see any option to disable the optical image stabiliser on my lens and hold it steady when running dji go camera.”*

*“This app doesnt work at all on my Samsung galaxy s8. The stream to my phone is horrible. Constant frame buffering and half of the time it doesnt even register my phone when I connected it to the wifi it hosts. It asks to **disable mobile data in which I do, but that doesnt solve anything.**”*

### 5.6 ConnectionSync

Nearly 12% of customer complaints are about connectivity or sync issues. They state that they were unable to connect to the drone or lost connectivity/sync during the flight which disrupts the video feed or telemetry data transmission.



### 5.6.1 Unable to Connect App to Drone

Many drone app users had faced connectivity issues with the drone, which could have been caused by an update or device incompatibility or lack of support for certain drone models. Some cases also report app crash occurrences upon connection.

*“Can not get app to connect to P4”*

*“Wont connect to my ar drone 2.0 using galaxy s7 edge, it connects through official app and through my laptop so something wrong within the application please fix as if love to try this”*

*“App does not connect to my xdrone wifi.... Unable to use x drone app”*

*“Not for the parrot 2? Doesnt seem to Connect to the parrot 2. Be good to mention this.”*

*“Cannot connect to the dji rc,dun know why they design an app that not **compatible** with it,not user friendly...”*

*“New update keeps disconnecting my mavic”*

### 5.6.2 Keeps Disconnecting from the Drone

App users complain of the drone continuously disconnecting from the app. This may be due to a new update, which leads to the users raising queries regarding the trust and reliability of the app.

*“Keeps disconnecting from mavic :/”*

*“Disconnects far too frequently, most often mid-flight, and has the hardest of times connecting to the drone (9/10 starts up saying the drone is disconnected). Shame, since it used to work really well until the last couple of updates..”*

*“Using galaxy s8+ and **always getting disconnect** and also always restarting my phone when going through different sections of the app example profile file section Please fix this problem as its a bad bug”*

*“Constantly crashes and **disconnects**. Cant update. Dont understand why the developers havent fixed the android issues.”*

### **5.6.3 Syncing Issues**

The drone app’s main functionality is to control drone navigation, which is achievable through the connectivity established between the app and the drone and the synchronization (sync) maintained throughout air time. While many drone apps users complain about connectivity issues, a few also grumble about sync problems. Among the negative feedback related to sync issues, most of them complain about data loss or game progress loss upon syncing and a few of them state that they were unable to sync the images and videos.

*“**Lost gold due to error with sync**. Tried numerous emails to their support group, but got no help in getting lost gold back. Dont seem helpful, but happy you spend gold on their game. Game is great, but beware spending gold.”*

*“**The game synced and erased hours and hours of accomplishments**”*

*“**Cant even sync** with the drone let lone this useless app. Pointless. Deleting!”*

*“Keeps disconnecting with Nokia 6.1 with 8.1 Android. Have to forget network and reconnect to be able to fly it. More than often **not able to sync images and videos**. All the above problems are gone when using an iOS device. There doesnt seem to be any updates coming either as the lastest one was many many months ago.”*

### **5.6.4 Camera Connection Issues**

One of the issues discussed in the Connectivity complaint category is about camera connectivity. People state that there was no option to connect to the camera or if there is, the app loses connection with the camera, thereby rendering the app useless since the main motive of using the drone is to adjust camera settings or angles during airtime and capture pictures or

record videos.

*“This app kept disconnecting my phone from the drone and didnt allow me to fly. I was **able to fly without the camera connection to the phone but the whole point in buying it was to use the camera.** I am taking the drone back.”*

*“cant get my smrc 6 to **Connect the camera**”*

*“Useless App cant do anything with it. **Cant connect the drone camera...**”*

*“If I could give it a 0 I would. **Will not connect to camera,** or even show its available.”*

*“Freezes and crashes with a nexus 5x on the latest software. **Looses the camera connection** all the time and disconnects mid flight. Needs fixing asap as I use this for business!!! Shame as I finally got the mavic after all the delays!”*

## **5.7 Cost**

Users criticize the drone app costs. Most of the drone users for whom the app did not work demanded a refund. According to some other users, even though the app works fine, they feel as though the app is not worth the amount of money they paid. A few also mentioned that similar apps with the same kind of functionalities were available for free and the paid apps were not worth the cost. Many users regret buying the app and consider it as a waste of money. A minor portion of the users laments that apart from paying for the app, they were asked to pay for in-app purchases too, which was annoying.

*“Couldnt connect to my Phantom 3 Standard even after 20 times. **10\$ spend for nothing!!!!**”*

*“Removed the Cardboard Option - Do not buy They used to have the Google Cardboard option for free, now they want to charge you another 1.5\$ for it. **The app already costs 4\$, do not buy this App.** You can download the apk for free, the developers sadly seem to only care about putting a **price tag on every little feature** there is.”*

*“Hate it The tracking sucks. The app itself is not easy to connect. **It cost 25 dollars.** If it worked well it would be worth it.”*

*“This app sucks it wont link up on my phone.I got this drone for the camera what a **waste of money.***

*Im very unsatisfied.”*

*“My Phantom4 pro had no problems running on dji go app. Then I read about Litchi and all its awesome features so **I paid \$25** followed all instructions accurately installed it ,,, **BIG MISTAKE!** My P4 did not respond to controls and whats worse is that my sandisk 128gig internal mini sdcard is now unreadable & corrupted Litchi is not all that it says. Filled with glitches and hangs, very dissapointing upsetting and **costly** because I lost all content on my mini sd.”*

*“wow... never seen a plane game that **cost so much** to buy different planes. especially with real money”*

### **5.7.1 Pricey App**

Most of the paid drone app users complain about the high cost of the app. They also compare the paid apps to the free apps and state that they could have opted for the free apps since they provided similar functionalities and also because the paid app’s features were not satisfactory or worthy of the amount paid for it. They also complain of many lacking functionalities in the paid apps because when customers pay for a product even when free options are available, their expectation about the paid app is very high.

*“**Too expensive,** widget doesnt update, cant customise widget”*

*“**money money why cant it be Little cheaper** i just left HAWK it was a big change after 4 years playing HAWK i found this game it started good at the beginning even with ads but now got to*

*much for me to expensive”*

*“**High price** and no support for other easycap models. And forget about the refund than dealing with developer writing broken stupid English as if with a log sticking out of his anus(each flicker of the log gives him freedom{ Dev. last reply saying with refund I get freedom} .. I mean Pain! . Also bought cardboard option and very disappointed!”*

*“The app is not showing correctly on a Note 3. I can only see a part of screen which is annoying. Also the app needs a reset button on settings in case you change something by mistake (which is very easy - at least on my phone, the way the app is showing). By making the **paying app so expensive** (24 hours prediction is not useful unless you have hours of spare time every day and you dont need to plan ahead), you just invite other developers to make a similar app for free. You must realize that for most of users it s just wind, precip% and possibly kp that matters (other measurements dont fluctuate so much or can easily be considered by each pilot on spot). It will be more affordable in the end to just **take a look at 2 other free apps instead of paying 26.74 euros/year**. Greed can be a bad adviser. Just my 2 cents.”*

### **5.7.2 Pay Twice**

A small number of paid drone app users accuse that the app compels them to pay twice. In a few cases, the users had initially bought the app and installed it on their phone, later had to uninstall it for some reason, and while trying to install it again, the app seemed to ask for payment again. In some other cases, the app was bought at the outset, but later when it was updated, it again required payment for the update, and this seemed to annoy the users. A handful of users also complain of the paid app’s in-app purchases since they feel it is a double payment.

*“Was a great app, but being **asked to pay for it again**, so I star as Im not paying twice”*

*“**Double payment?** I paid upfront and then a had to do an **in app payment** why?”*

*“Im being asked to repurchase the app. I had purchased the app last year. After having used it for some time, I had to uninstall it to free up space. Now when Im trying to reinstall the app, Im being asked to pay again. Ive even mailed the developer about it but havent received any response yet.”*

*“Scammers Buy the app months ago, and **then update it to incorporate new options, but paid,** gentlemen if they already charged once they can not charge again without justification, if they had communicated future **charges with updates** never un bought anything”*

### **5.7.3 Pay for Extra Features**

Users often complain that they have to pay additionally for essential features, even though they paid for the app initially when they purchased it. They criticize that most of the essential features are available only for an additional cost while other apps provide them for free.

*“**Have to pay extra for camera** When you buy the app you have to buy the camera also. So it cost you twice as much as you think. Could not take pictures while video was running.”*

*“**Everything important** (widget metar, runway x-wind) **must pay** other apps provide for free”*

*“pay for the app only **to need to pay again for each photo?** garage”*

*“Good features **but To get all the features you need to buy** a further two items thankfully there 10p as well”*

### **5.7.4 Purchase Items Not Awarded**

Certain users report that they did not receive their in-app purchase items and hence demanded the app to provide either the items or a refund. A few users asked for reimbursement since they were dissatisfied with the procured in-app purchase features.

*“I enjoy the game, however Ive made two purchases and the **things Ive purchased arent reflected on the game.** please either give me the items Ive paid for or refund my money!”*

*“**problem with a purchase**, the royalty pack is not giving what it is advertise to give, player id 21202041, already give all infos relative to the purchase, my request is getting ignore when i asked to receive the items or a refund, iM getting ignored, i ...”*

*“The game itself is awesome, just one thing though. When making a **purchase the items you buy do not update** after the app restarts.”*

*“**Purchased items. Card was charged, never received anything.** This is ridiculous. Im deleting this right now.”*

### **5.7.5 Refund**

The paid drone app users demand refund since the app has too many functional errors, or the app is not working as expected, or crashes unexpectedly, or is incompatible with their device. In some cases, the app had some fatal functionality bugs, such as some operation causing the drone to get out of control from the app and also the RTH (Return to Home) feature failure making the drone to drift off, leading to drone loss or heavy physical damage.

*“it sure would of been nice to know **it doesnt work with android. I would like a refund.**”*

*“Are you kidding me... Crap works for 5 seconds then shuts off. Spent 10 dollars on this garbage. **I want refund**”*

*“**Can i get a refund.** The app always crash after a minute.”*

*“Well... **I would like a refund...** the only reason I paid \$29 for this app was to use the tracking feature... every time I draw the box the video drops. This is after I figured out that you cannot have your histogram up while filming or you will get an instant strobe effect to put you into a seizure, thanks for that. Ugh... waste of money”*

### **5.8 Customer Support**

The Google Play Store customers complain about the app-support not being available for

the app when they reach out for help. While some reviews suggest that the support is taking too long to respond, some say they did not receive a response at all. Few users have also complained about customer support being very unprofessional in their response behavior. Customers also hope that the developers will fix the issues faced.

### 5.8.1 No Response

In the case of customer service complaints, most of the users accuse that they do not receive any reply from the support team.

*“Terrible. Last update prevents use of the device without upgrading the fc system, but wont allow you to actually update it. **Customer service will not respond to my requests for support.**”*

*“1st it was the firmware now my pht 3 app crashes and wont connect. email suppprt over a week ago and no reply. crapy no service. 1200 dollars for this drone junk. I should of read the review before buying it. **at least reply to ur email**”*

*“this sucks, cant get it to work , **support doesnt answer**”*

### 5.8.2 Delayed Response/ Urging for Response

The Drone app users expect some kind of response or reply to their posted reviews from the developers. In the case of delayed or no response, users tend to complain about it. While many users request for a reply to solve their issue, some people urge the support team to reply by promising to update the review score only after receiving a response.

*“Worked twice and then it wouldnt connect to video. **It took ten days to get a response from support.**”*

*“GREY ZONE. #zone3 Impossible to complete the level. I have done most of the updates to drone with includeing of bombs. Why do is this zone hard than first 2? **Developers if listening, please reply.**”*



*“this app working great before 1.16 version updated. but since update, my app crash and cant use again. black screen app not responding every start app on my phone. i use phone ASUS ZE551ML 4GB RAM. crash report was sent to email maxim L. **can you please solving my problem..?** thanks soemar.tm”*

*“got double charged **will review after sufficient customer service.**”*

*“hello developer? can you give me reply,because its important for me,**after your reply i will give you five star for your reply.** the question is: i have doobby drone with noproblem on my system”*

### **5.8.3 No Help Available**

Some customers indicate that there is no help available from the company or online, or that they did not receive the expected help from the support team. In a few feedbacks, it is specified that support was not available for the trial version.

*“**Absolutely no help or support from company.** Thats what we get when buying from foreign country. No consumer protections !!!!!”*

*“Doesnt connect I have tried about 20 times to connect to my Phantom 3 standard and it continues to fail. I have restarted everything several times. **Cant find any help online.**”*

*“Cant get the app to accept my username and password. I took the suggestion of signing up online and I was able to do that but now that Im trying to sign in from the app, it simply says unknown username/password. Ive double checked the password and I know Ive entered it correctly. It still wont let me in. I then tried the live **help option on the website but it says its not available to the trial members.** This is **poor customer service.**”*

*“Could never connect I spent several hours trying to connect to my drone. My 3DR telemetry radios work fine from my laptop, but not from Andropilot. **The help page isnt very helpful,** and*

*the troubleshooting page just has a note which says Working on it. Check back!. It was last updated 8 months ago.”*

#### **5.8.4 Irresponsible/Improper Behavior**

Rare cases criticize customer support team behavior and indicate that the support is acting in an unethical manner (which could be in response to rude reviews). Some people even state that support provides false reports to justify their app credibility. Few users also request for a direct reply from the support team instead of automated responses.

*“Its a 19 dollar clone of a free dji app. Btw..**customer service likes to argue and belittle** :(”*

*“App still not working on android 8 and higer,its working fine on 7.1.I have this drone from christmass and still waiting on update or some solution.Its shame for parrot that they cant fix a bug in two months.**Any serious response instead automated message?**”*

*“So just like an idiot i downloaded this app and its add on to use with my new just ordered SOLO before it was delivered by B&O camera. The next day I was informed by B&O that the drone package I wanted has sold out. I politely requested a refund for \$50 worth of software I will never use. **Unfortunately my request was ignored by the developer.** The software looks great, compared to the SOLO app, but i expected more from the developer. Too bad I have to step up my effort for a refund in this way. Stay classy my friend.”*

*“After update, crashes instantly and ruined my wedding aerial photos. Didnt get a single picture because DJI doesnt test updates very well. **They also delete your review when you tell the truth.** Its been over a week now and no fix.”*

#### **5.8.5 Poor Service**

Drone app users complain of poor customer service. A significant issue to note is that

some users have criticized the app developer's treatment of iOS versus Android users. They accuse that the developer is more favorable to the iOS platform and also provides very little customer support for Android users.

*"Until DJI choose to update this app to support Android Q, official release now for 2 months, I cant even open the app. I would give 0 stars if I could. **DJI Support are less than useless.**"*

*"DJI has the **worst customer support.** Unlocking fly zones does not work, ever."*

*"**Poor support** Now forces 1.6+ fw on Phantoms to work. Dont want Geo, use Pix4d."*

*"Come on Dji the app for IOS is great and does its job with ease while the Android app is just s\*\*t on a plate. When flying using my iPhone 10 and Mavic Pro I can go 1,500+ meters with no lag or signal loss. The second I use my s9 it goes 500 meters until either the video becomes do choppy I cant see whats happening or its a total signal loss, which is terrifying knowing your \$1000 drone is just flying with no connection what-so-ever. **The app support for Android is horrible (hence its low rating).** If you were thinking of buying a Dji product make sure you have something that runs ios as its full limits wont be reached using the s\*\*t Android version."*

*"**FINALLY AFTER ALMOST TWO MONTHS!** The app is finally fixed for Android 8.x devices. The app is fine when it works. If you own a newer device, Id proceed with caution, **DJI seems to give android second priority over ios** and their Chinese support is terrible."*

## **5.9 Device Compatibility**

This complaint type occupies a significant 19.74% in the percentage of overall complaints. Drone app users either complain about the app not being compatible with their phone or their operating system.

### 5.9.1 Android OS Version Incompatibility

Most of the incompatibility problems have risen due to OS version updates, such as the app not working after the user upgraded their mobile's Android OS.

*“Works best only on iphonen no so good for Android”*

*“After updating to Android 10, I cant seem to open the app.”*

*“I use Motorola One Power (Android One, 9.0 Pie) This app seems incompatible. I tried with other phones with Android Oreo, it working fine. With my device, the video and photo are not visible. Only color lines with gradations are seen. So its completely unusable. Plz look into this and provide a fix”*

### 5.9.2 Hardware Incompatibility

Reviews complain about hardware incompatibility issues such as the app not supporting the particular mobile model. The users were able to identify these by testing the app in different Android OS versions and on different mobile phones. Users believe that it would be useful if the app provided the list of compatible devices in the app description itself since they had to figure out the incompatibility after (purchasing in case of the paid apps) installing the app. Many reviews also stated that the iOS version of the same app was working marvelously while the Android version was a complete failure, suggesting that the developers should improve their support for Android devices.

*“Incompatible with my Redmi 5+”*

*“Does not work with Samsung Galaxy S8+”*

*“Does not work with my Note 9 but works fine with my tab s2”*

### 5.9.3 Incompatible after Update

A few users also state that the app updates are sometimes incompatible with certain devices or OS versions.

*“Buyers beware!!! With each update, there is a possibility that ur device will not be supported and you will be advised by support team to basically buy a new device. The app since the update no longer works on my tablet and based on their response have no intention to fix the bug.”*

*“Latest update broke on samsung s5, very disappointing, downgrading to previous version with less functions...”*

### 5.10 Device Storage

Very less feedback 0.81% is about device storage problems. This complaint type occurred mostly in Entertainment, Video Players & Photography. In some cases, the feedback suggests that the app update takes more space.

#### 5.10.1 Huge App Size

The user complains that the app is too huge in size and takes too much storage space (resource-heavy) on their phone. Also due to the large size of the app, it consumes more mobile data while downloading or installing the app.

*“Better than before but why is it so big... took more than 500MB of storage...”*

*“App should be smaller”*

*“too msny updayes that take more and more memory.”*

*“1 Star because of BIG SIZE of app. Consumes 350 Mb after installation.”*

### 5.10.2 App Fails to Detect Storage Space

The app fails to recognize the space and throws a no storage space error message when trying to store the videos or images that the drone recorded or captured.

*“i keep getting the **no storage error but storage is present**. what could the problem be?? I have over 11 GB free but i still get that error, why doesnt it pick the storage????”*

*“App **always shows not enough memory**. I have **64Gig** with at least 30Gig available! Way more than the 3 Gig minimum started in the manual!”*

### 5.10.3 Unable to Save Photos or Videos

The user is not able to save photos or videos due to memory or storage space issues. A few users also report issues in storage permissions.

*“Overall reasonable. Bugs: - doesnt remember settings for photo/video quality - on first start it only prompts for location permission, **storage permission seems to get cancelled before it can be granted** - this means it then doesnt save photos/videos until this is manually added - no battery percentage - firmware update process could be made easier with description re wifi switching, etc. - also show current and proposed FW version”*

*“I cant save the photos or videos made says: **no memory available I have 5Gb free**... Maybe if added an option to select where to save the photos (?). Please fix....Only installs on Chinese and has to be changed manually on the options (should detect the phones language...)”*

*“cant save photos or videos on S8 plus”*

### 5.10.4 Memory Leak

A memory leak happens when a computer program does not manage memory allocations in an appropriate manner such as the memory, after its use not being released back to be used for other programs/applications.

*“On a pixel phone: **this app has memory leak**. Makes my phone so slow and lag. And when I delete it it runs perfect again. Really afraid to use it to fly with it. I think they wont change it.”*

*“Version 2.1.5 **has serious memory leak** and made my phone unusable (had to wait 5sec for any action to finish). Even restart does not help, only uninstalling it fixed the issue.”*

## **5.11 Feature Removal**

Feature Removal is one of the least complained about the topic. The feedbacks were about the users suggesting that the developers remove the specific features that they are not fond of, from the app.

### **5.11.1 Feature Removal Request**

These comments were about the user not favoring particular features and suggest that the developers remove it from the app.

*“please remove data synchronization as it is rendering my bebop 2 useless without internet.”*

*“How to activate recording features? It seemed can be activated but how? If recording cant be used, you better remove it so everyone not put hopes on this app”*

### **5.11.2 Regret for Removed Feature**

Some reviews complained that the feature the users liked had been removed in successive updates and requested for them to be added back again.

*“Stats not showing In fpv mode Before you could see the stats while flying with fps Googles. For some reason this has been removed on the last update.. so now I cant see how much power on the drone or controller I have left.. love everything about this, and the app. **But why remove this feature? Seems ridiculous. Please bring back so I can use fps again.**”*

*“Why did u remove USB cable connect between spark and mobile phone. Fix it as soon as possible Cannot able to use my drone without it”*

## 5.12 Feature Request

Customers provide suggestions asking for some features to be added to the app.

### 5.12.1 Request for New Features

Some users request the app to add new features or to support more varieties of drones, or to support more Android OS versions. Few users also request to support higher drone altitudes.

*“Needs slow motion for android!!!!”*

*“Needs facebook live feature. Yuneec....dont be an apple only company like dji.”*

*“Please makes support for DJI Spark”*

*“Needs support for Phantom 4! This is the app I have been waiting for. Why no Phantom 4 support?.”*

*“its not bad. **needs more drone models/makers added** i cant add my skyviper s1750 or my propel XØ1 mirco to my list of drones.”*

*“App is great but theres a few things that I think are important that **need to be added**. \* **Ability to raise altitude limit to 99feet at least**, normal tello app already allows this. 30ft limit isnt the best, especially since this app helps fly longer distances. \*ability to change/rearrange the 8 hotkeys at the top center.”*

### 5.12.2 Request for Trials

Some users also ask for features such as requesting for trial versions to be made available or to extend the trial period time of the app.

*“Not enough time to try it out **How about a 5 minute trial period** so we can actually go on a flight. By the time its all set up and synced the 2 minute trial period has just about expired.”*

*“**Time based trial needs to be rethought**. Paying for this app is a no-brainer, if it works- but it sadly doesnt support my drone so I cant even test it.”*



*“Thanks for the demo. For the cost of messing around with your app for **20 minutes** I found out why I shouldn't waste any money on it, total fail to connect with DJI Phantom 3 Standard and HTC One M8. No sale. By the way, that's a very odd demo approach. **a timed trial of a day or so would at least give people the chance to debug your app install.**”*

### **5.12.3 Request for Unit Conversions**

A few others mention that it would be more convenient if a conversion of units existed for some attributes, such as temperature units being only available in F units, suggesting that it would be nice to flip between units such as Celsius or Fahrenheit.

*“could use some additional features but works would be nice to be able to select C instead of F for temp and also see further ahead than 24 hours”*

### **5.13 Functional Error**

Most of the feedback in the analyzed dataset belongs to the category of Functional errors. 25.86% of the total reviews belong to this complaint type (the highest percentage among all complaint types). Users complain about some feature not functioning or working properly. This type of issue was commonly found in controller apps. For example, *“Video recording on my galaxy s8 but no sound”* review complains about the audio feature not functioning in the app.

#### **5.13.1 Log In/ Registration Issues**

Many users have mentioned log in issues such as not able to get past the login page, or authorization and registration issues. In some cases, the app says invalid email account, or the user registered already even though the user is registering for the first time.

*“Im using my Samsung Galaxy J7 10 and **when I log in the app just shuts down**”*

*“Were sorry... Unexpected error when handling authentication request to identity provider.*

***Continually receiving this error when trying to log in to authorization for fly for fun. Also it is***

*not clear whether hospitals need to be notified with helipads. Emergency is a very small red dot on the map God knows where even though I hear a helicopter outside.”*

*“Update: They asked me to log in to their website as if I havent already tried that...it doesnt matter where I sign in from, online, through it the app, wherever they have a log in screen, it doesnt work. **I keep getting the Error 406 code with invalid log in.** Is their tech support really this ignorant? Or are they just ignorant? Do not install this app, it is full of bugs and its developers have no intention of fixing the problems...”*

*“Log in problem I have tried to register with both my email accounts and get told that my email address is invalid....Why they work perfectly with all other apps?”*

### **5.13.2 Access Issues**

Users also accuse that they were unable to access the photos and videos taken or not being able to access their memory cards. Few of the cases report that they were not able to access a certain mode of operation.

*“When it works, the app is great. But I cannot connect to the my.parrot account, so **I cannot seem to access the photos I take.** It takes me to a screen saying pick an username, then when I click past that with a username it gives me an error screen. This is a pretty major issue.”*

*“alot of features. I cant update solo, nor can I use any options listed in the details. Like everything is grayed out and **wont let me access the different modes.** I honestly want my money back”*

*“**Cant access video without connection to device.** Doesnt save to gallery.”*

*“the app definitely needs some serious work done to it, one day its working fine and then the next it refuses to let me access my Mavics memory card, and on top of that the panoramic feature*

*refuses to work, Id be less fussed if the weather in the UK wasnt mostly rubbish for flying. if i only get 1 or 2 days a month to fly the thing Id like the app to do its damn job properly!”*

### **5.13.3 Bugs**

Customers complain of bugs in the app that impair certain functionalities.

*“**Has bugs on it Does not works as described.** Does not saves images to you phone gallery and you have o turn on the drone every time you wanna see the pics videos...also I didnt figure how to download or post the videos...about to bring back to the store”*

*“Parrot i think your company just committed false advertisement with the last upgrade. Its was **supposed to fix bugs now im losing control of my drone after 50 feet.** Either fix or i make a complaint to the FAA and Better Buisness Bureau. Consumers are protected by laws under both. Due to **faulty upgrades**, Parrot has put both drone operators as well as other civilians in danger from crashing drones. Hopefully you look at the issue before someone gets hurt!”*

*“**bugs cant view the drone** android phone:samsung a6+”*

### **5.13.4 Display Problems**

Some feedbacks complain that the users were unable to view certain features such as map display or camera vision. Few users specified that these types of issues occurred after updating their app.

*“Have yet to be able to even fly the phantom 3 Standard because the remote always has a weak signal no matter what I do. The **app will not display the camera view at all.** This is a huge pain in the ass for a product that cost so much!!”*

*“**map doesnt display.** sent email to the app owner which was undeliverable. appears to be an app that has been abandoned.”*

*“After updating the app it keeps crashing, and **will not display the fpv camera** on my Samsung galaxy s4. Tried updating firmware and reinstalling everything. Nothing works!”*

*“As well as I like the standard Litchi, that much I dislike the version for Osmo. Many issues, and of the most frustrating is that after just 2-3 on/off iterations, **Litchi loses video display from Osmo**. It connects to WiFi, but there is no video. Tried many times, easy to reproduce, result was always the same. For the given price, this is not acceptable. Product was released w/o proper testing.”*

### **5.13.5 Unable to Take Pictures or Record Videos**

Some of the comments state that users could not take photos or record videos. Few of them pinpoint app updates or lack of support for certain drones to be the cause of these functionality errors.

*“**it cant take any picture or video...im using huawei mate 10...please repair...**”*

*“Flying Phantom3Pro - **didnt take any pictures despite carrying out the flight plan**”*

*“**Worked fine up until the latest update** on Dec 26th. Curently able to connect to drone and take off but **have no camera feed and cannot take pictures.**”*

*“The **latest version cant take pictures on the Phantom 3 Standard**, the drone flies according to the set flight plan but a Photo capture not responding error always appears at the first waypoint. I had to roll back to the previous version to get it working”*

### **5.14 Installation Problems**

Users complain about not being able to install or download the app. In some cases, it is not installing due to incompatibility issues.

### 5.14.1 Unable to Install

Users mention that they were not able to download or install the app. In a few cases, the installation was complete, but there was no icon created to launch the app. While some users were able to identify why they were unable to install (app did not support the phone/tablet), others were not even aware of the reason.

*“Wont download I kept getting an error code -505 when I try to download on galaxy S6”*

*“not sure why i couldnt install this app. hai..”*

*“Down loaded app ...no icon cannot use. Bad experience. Two hours now and no success researching issue of no icon. Very disappointing.”*

*“It would be so much better if the app supported installation to tablets”*

*“I emailed you on the 22nd March 2018. I have not had a reply. **Despite purchasing the app, it does not appear in my apps.** When I click on the pro app in Google play it says it is installed. I tried clicking on the open in play store app but it just says the page is not found even though my connection is fine. The device it was supposed to be downloaded to is a new top end samsung tablet. I also sent you screenshots in the email. I need to dispense with the adverts and be able to download the pdf checklists.”*

### 5.14.2 Delay in Download

A scarce quantity of complaints denotes that the installation consumes a lot of time.

*“It takes more time to start **downloading** other than other app doesnt **take this much time** so whoever is going to download this place **dont download it**”*

*“It took forever to down load”*

### 5.14.3 Reinstallation Issues

In certain cases, the drone app user uninstalled the app due to bugs and while trying to reinstall the app, they were unable to download it. In a few cases, the user uninstalled the app due to app malfunctions and tried to reinstall believing that this would solve the issues, but it did not.

*“I had before then it start going weird, **try to reinstall it and doesnt want to let me download it**”*

*“It worked fine the first time I opened it and retrieved the METAR for my area. Since then it wont update the report and just spins. **I tried reinstalling, but no luck.**”*

### 5.15 Lack of Functionality

Reviews mention an absence of app functionality such as lack of legend in a map. These types of complaints mostly occur in categories such as ‘Weather,’ ‘Video\_Players,’ ‘Tools’ & ‘Photography.’

#### 5.15.1 Lack of Information

Feedbacks belonging to this complaint type often specify the app missing vital information.

*“Decoded information does not display weather phenomena, only wind, clouds and visibility. I prefer RAW data anyway, but people that rely on decoded info should know **they are missing out on important information** (mist, rain, snow, etc are not displayed)”*

*“Not realistic It does not discriminate between a helipad active once per year and a major airport. Basically all populated areas are marked no fly. **Towers have no contact information.** This app is effectively made useless.”*

*“Slow to load. **Doesnt give contact information to assist with notification.** Doesnt give a map of the airport coverage to help locate airspace away from airports, heliports, and helipads. unable*

*to search for cities. search only uses gps coordinates. doesnt always update location properly.  
Doesnt have accounts.”*

### **5.15.2 Missing functionality**

The drone app users also complain about missing functionalities.

*“This app is not working properly on my samsung S7 with android 8 on the disco. There is **no telemetry information or antenna tracker locator in fpv mode** . No green writing info on screen at all .. The app worked just fine on my old phone a samsung S5 which had android 6 . Please fix this parrot .”*

*“**Cant view maps without drone connected.** Cant use flight simulator without drone connected”*

*“Huawei MediaPad T1 7.0 tablet detect UTV007 device but **NO VIDEO or AUDIO.** but this USB Camera Pro - Connect EasyCap or USB WebCam app gives me audio.”*

*“**lack of upgrade, lack of energy, lack of reward, pretty much lack of any resources;** on top of all you open a magic box, how the hell you dont get in your items. If you wanna pay to win be my guest, but im not going to win stuff and force you to buy it. really come on man, where is the entertainment, nothing but confusing. im a gamer, and i have never had any games where it is so confusing then this game. im really embarrassed to recommend. only thing is DELETE!.”*

*“**No live feed** on pixel 2 xl...”*

*“**No 60fps support, no slow motion,** zooming is glitchy... Overall not a very good experience.”*

### **5.15.3 Lacking Airport Information**

Feedbacks complain about missing some airports in the list of airports displayed. Some of them were location related issues as they did not support other country’s airports.

*“**missing international airports**”*

*“Was good when it actually showed all airports. **Now app just shows major airports.** According*

*to Airmap Im now good to fly right over a bunch of smaller local airports. They dont even show on the map now.”*

*“Useless. **Doesnt show Palo Alto airport.** Airports it does show provide no contact info. Needs access to my photos for no good reason. Asks to submit flight plan, but doesnt notify nearby towers. Unclear what problem this app is trying to solve.”*

*“**Doesnt contain all airports local to me.**”*

*“**unable to locate major airports**”*

*“Used to work great but now it **no longer supports Canadian airports**”*

### **5.16 Missing Notification**

Drone app users, controller apps in special have to notify local airports before flying a drone within five miles of an airport. Users complain about the apps lacking these notifications to airports. Also, few users expect notifications when the app is updated.

#### **5.16.1 Lack of Notification**

Drone app users complain that the app fails to send appropriate notifications.

*“**Notifications have never worked** on my Samsung s8. I have all alerts set.”*

*“tried to sign up but it **never sent me the email notification** and theres no way to get another one”*

*“Overheats my phone. When there is an **app update I never get a notification.**”*

#### **5.16.2 Registration Code Notification**

Users complained about missing OTP code for registration which has to be sent to their mobile. Some users did not receive a pin number to their email id. These led to login issues.

*“**Not getting OTP message.** Obviously not an isolated issue from number of people affected.”*



*“The phone verification system is useless as I have tried many of times to verify my number to AirMap. Never received any verification SMSes”*

*“Im still waiting on confirmation email to be sent. In the mean time, Im sitting here idle not able to fly my drone.”*

*“i didnt get my redeem code yet and i did pre order the game”*

### **5.16.3 Notification to ATC (Air Traffic Control)**

Drone apps notify airports in advance before flying a drone within five miles of an airport. A few feedbacks comment on the lack of this notification. (NOTAMS - FAA Notice to Airmen).

*“First couple times I used it, the app sent notification to my local ATC. Now i no longer get the option and no verification code is sent in reply. Wondering if Im breaking the rules. Any help would be appreciated.”*

*“Airmap not so good Like the idea but some airports in the region (all) do not receive digital notams”*

*“Local Airport Air Traffic Control Tower (CAK in Canton, OH) does not receive notification. I spoke with them and they confirmed that they will be implementing the system around November, but a phone call is still required at the present time. The app does not tell you if the airports are yet implemented, nor does it confirm that the notification was successful or acknowledged.*

*This is very deceiving, and will cause the pilots to be flying illegally if they assume everything was successful, as the app implies. The idea is good, and the app itself is useful, but presently lacks the necessary requirements to legally fly without physically calling the Air Traffic Control Tower. I heard about this app locally from fellow peers who use the app, and sounds like word of*

*mouth is spreading about the app, but not the legality. Just a heads up, call your Air Traffic Control Tower to confirm whether they actually get the notification.*

## **5.17 Network Problem**

Some users complain about server timeout errors and server connectivity problems.

### **5.17.1 Server Connectivity Issues**

Drone app users often complain about server connectivity issues in Network problem complaint type. Mostly it is about not being able to connect to the server.

*“**Server error**”*

*“good game, but the daily quests never renew so Im stuck on day 3 also whenever I try to play online I get **cannot connect to server** but it seems to be fine if they want money... then it can connect to the server no problem”*

*“Havent been able to play this game for 3 days especially the PVP comp, the Tournament or the 2VS2 competition keeps coming up with **CANT CONNECT WITH SERVER**. This is what I like playing, against other Falcon Nites.”*

*“Complete garbage always **timesout server error**”*

*“**Unable to connect to dji servers** despite having a stable Internet connection”*

### **5.17.2 Network Unavailable**

A few have complained about network unavailability issues or not being able to connect to the internet. Many feedbacks mention Wi-Fi network issues.

*“**network unavailable** - phone is connected to the internet correctly”*

*“keeps saying **network anomaly**. doesnt ever do what I want it to do. cant connect to the drone. thanks for making a horrible app.”*

*“The apps can not connect go internet for login even the wifi signal is good, using oppo phone”*

*“wont connect to network, cant even create an account”, “I couldnt connect to wifi”*

*“I dont think this app is finished because the **WiFi network does not pop up** on my Galaxy S7”*

## **5.18 Performance**

These types of issues occupy 10% of the total complaints. Customers often criticize about app inaccuracy in Performance complaints. They state that some of the apps show incorrect wind speeds, weather data and fly zone information. Other major issues were glitches, video lags, and poor graphics. They also complain about the app being slow and taking too long to load. Some reviews also mention stability issues as they grade apps as being unstable and unreliable.

### **5.18.1 App Inaccuracy**

Drone apps are accused of inaccuracy in nearly 23% of the Performance-related complaints.

*“**Not accurate.** Shows ok to fly in National Parks and within 5 miles of smaller airports. Dont rely on this until they fix it.”*

*“Good app to have as reference. Good synthesis of data in one screen. **Some weather data is not perfect**, but with all weather apps happen the same. I uninstalled tired of the frequently updates each one or two days.”*

*“Shows airports where none exist and doesnt show one that I know exists!”*

*“No fly zone size information is incorrect. It looks to me like it might be a mix up between miles and km. You are better off using the FAA B4UFLY app. Nice UI though.”*

### 5.18.2 Lags & Glitches

App users also complain about glitches and lags in videos and images captured by the drone.

*“This app used to will fine till I updated. Now after a few minuets of flying the **camera display goes very laggy** (about 30sec late) and then the app stop running all together. Then my whole phone runs like crap till the OS forces the app closed. My phone is a S6 Edge. Please fix this asap or aloud me to rollback the app.”*

*“Garbage app. **Laggy** and you basically cant fly anywhere according to the app.”*

*“Does not work properly. **Glitchy streaming to the phone** and keeps crashing during the panos. I do not recommend this app. Im requesting a refund right now.”*

*“Crashes, **glitches destroy quality of image**, cutomer service sucks, batteries burn up, they dont back there product at all, they a careless toward there consumers. My next purchase will not be Dji. Show me other wise... prove it to one drone enthusiast that your product, price and service exceeds any other.”*

### 5.18.3 Poor Graphics

Customers also lament about the picture or video quality. They state that the app is slow, and the video quality is very poor.

*“Its really heart breaking to play drone shadow strike 3 after playing shadow strike 1. **Very poor graphics**.9.99 out of 100 marks.”*

*“Basically the same as drones 2, **but worse graphics**”*

*“**the resolution frame is not high enough**..fix it !”*

*“Not a bad app, could use a lot of refinement though. A little **slow at times and video quality is very poor**”*

#### 5.18.4 Slow & Loading Issues

Drone apps are criticized for being slow and taking a lot of time to load.

*“Slow, laggy poorly thought out.”*

*“Maps slow to load I find myself not using the app as much as I would like because it often **takes a long time for the map to load** and sometimes it wont load at all. For some reason the files are much bigger than Google maps or dji go. I tend to have slow connection when Im out filming but Google maps works fine as does the DJI go app even when they havent been previously cached”*

*“To much latency! Unusable and dangerous to fly with this app. I want my money back!!!”*

*“It takes too much time in loading”*

#### 5.18.5 Unstable

In performance-related complaints, users also indicate that some apps are unstable and hence question the app reliability. Some users specify that image transmission is very unstable. In a few cases, the app became more and more unstable with every new app update.

*“Poor Cant record video . **Unstable** at first for me . Free programs much better . I wish I could get a refund .”*

*“Custom startup movies dont work, keeps telling me cannot play this video app becomes unusable, **speed settings unstable**, changes dont always apply. Galaxy S4”*

*“Using Samsung Note 5, after update the new version of App, the **images transmission very very unstable....recording of the video be come slow motion..... suck.... pleaaee resolve the issue soonest possible....**”*

*“**More unstable with every new version.** App crashes mid flight Nexus-5X.”*

## 5.19 Privacy Ethical

Reviews either complain about privacy or ethical issues such as app safety, app permissions, and legal issues.

### 5.19.1 Permissions

Certain feedbacks reveal that users are annoyed by the app asking too many permissions or asking for irrelevant permissions.

*“app demands storage permission. there is never a reason for an app to ask for this permission unless is central to the function of the app. odds are, it is personal information theft.”*

*“WHY DO YOU NEED LOCATION, AND WHY DO YOU NEED TO MANAGE PHONE CALLS AND OTHER PRIVACY STEALING PERMISSIONS? IMMEDIATELY UNINSTALLED AFTER SEEING THOSE POO HOLE DEMANDS.”*

*“Why does a map based app need access to my files, photos and camera? This is the worst thing since Fred Dursts musical career.”*

*“Device ID? Call information? Why does an app to fly a drone need to know my call information? Too many extra permissions! Care to explain why?? Also not intuitive at all no idea how to use app, no i structions when opening app!”*

### 5.19.2 Legal Issues

Some reviews complained about the app acting against the rules of the FAA (Federal Aviation Administration). While a few others protest against FAA rules and also mention that the app supports a legislation bill that imposes strict rules on drone users.

*“AirMap decided to work to create a legislative landscape of utter confusion, deserting decades of successful FAA oversight in lieu of a complicated patchwork quilt of local, state and*

*Federal laws, bans and regulations. Why? So they could create the solution?!? A **business** should NEVER bite the hand that feeds. DELETED!!”*

*“Is this regulated & or approved by the FAA? If so i will give 5 stars if someone tells me”*

*“Uninstalled after hearing about the legislation bill that they are supporting. Dont install.”*

*“Airmap is in support of Fiensteins drone federalism bill and a patchwork of state laws that would hurt the entire industry. App is uninstalled as they only care about there bottom line and not the Industry. There are several other apps out there that can do the exact same thing. **Do not support this app. Uninstall and use an app that actually supports the industry.**”*

### **5.19.3 Reluctant to share Personal Information**

A few feedback comments questioned why the app needs too much private information to log in and were reluctant to share personal information.

*“Why does the app require all of my personal information? Isnt this a prime example of big brother violating my right to privacy.”*

*“uninstalled. Not sure if I am required to have this app but not reinstalling because **it seems to want more info than it provides, such as pictures and contacts on my phone.**”*

*“Needed my info ”*

*“I would like the developers of the app to justify the reason for such elivated privileges. **Why does this app require access to so much personal information.** The terms and conditions of using this application **forces the user to give up there privacy rights.** Dji state they are collecting personal identifiable information. Companies like this should be boycotted.”*

#### 5.19.4 App Security

The drone app users also questioned app security as their antivirus marks the app as a potentially unsafe application. A few reviews state that the app has a virus. Some users have warned the others not to use the app since their card information has been misused.

*“My antivirus had a big problem saying this was a potentially unsafe app.”*

*“my antivirus say potentially unsafe application android /packed.secneo.A.(variant) include various hacking and cracking tools ??? what happened with user privacy ?”*

*“This reports a virus in ESET mobile antivirus security. Ive bought a drone that relies on this software. How am i supposed to use this on my phone without getting infected????”*

*“Viris. Cool for ur drone but always gives a virus”*

*“DO NOT DOWNLOAD. I am now recieving chinese telemarketing calls. They steal your information & more likely sell it.”*

#### 5.20 Resource Heavy

Reviews are categorized into this complaint type if the drone users complain about more resource usage such as huge app size occupying a large storage space, heavy battery drain, CPU (Central Processing Unit) or RAM (Random Access Memory) usage. The high resource usage could be because of the app and some of its services running in the background even after users exit from the app.

##### 5.20.1 Storage Space

The drone app is accused to be too large in size and thus taking up too much storage space.

*“Better than before but why is it so big... took more than 500MB of storage...”*

*“Worst app ever It needs tons of storage and it is very hard to use”*



*“When they get it working with the s8+ I will rate it properly. Right now its just **taking up space on my phone. Too bad.**”*

*“I like the idea of this app in that it tells vital information for drone enthusiast. The problem is it only finds location at my home. Whether on wifi or not it does not work for me anywhere but at my home? If this continues I will probably uninstall app because **it does take up quite a bit of storage space.** These are the reason for just 3 stars. Fix and I will review again.”*

### **5.20.2 Battery Drain**

As seen previously in the Battery complaint type, which can be considered as a subcategory of Resource heavy type, some drone apps drain the battery even when the app is not in use. The battery drain is due to some app services running in the background. In some cases, a huge amount of data is transmitted to the server without the knowledge of the user, thus over-utilizing the mobile data of the app user.

*“**Serious battery drain**”*

*“**Battery drains at ridiculous pace** Wont fly for more than 2 or 3 minutes”*

*“**The app keeps using battery in the background.** This app uses 2 percent of my battery per hour even if I havent used it. Since it is the only way to control the drone, I reinstall it every time I need it.”*

*“App is good, but... It installs mdnsd service that occasionally starts **draining the battery even while the app is not in use.** If your battery seems to die quicker than it used to, uninstall this app.”*

### **5.20.3 CPU/RAM Usage**

This type of feedback complains about the processor or RAM memory over-utilization.

*“Embarrassed at my Government. Consumes all cpu/ram, then freezes phone and tablet until the app crashes on both.”*

*“Memory **Memory this app use is a lot**, then freeze. Not able to see picture or update without connecting to a pc”*

*“DJI should make DJI Spark standalone app because all these updates are just **killing the phone memory space and breaks functionalities** that have been working great for DJI Spark.”*

*“**This app is constantly running in the background.** Attempts to prevent it have proved impossible. **Why does it need to be in memory when you're not using the drone??**”*

### **5.21 Spam Notification**

These complaint type reviews accuse that the apps keep sending spam notifications and advertisements that are annoying to the users. One such case mentions that the app sends superfluous notifications pestering the user with tutorial videos and pictures. Some reviews also state that their personal information provided to the app has been sold to other telemarketing companies since they received calls from them after using the app. Few users state that the app keeps showing alerts even when it is turned off.

*“**DJI is now spamming my phone with their ads and notifications.**”*

*“**Mostly this app does a good job of controlling my DJI drones, I wish it wouldn't clog my phone with pointless how-to Videos & photos.** Why it adds them to the camera roll is beyond me, and it's immensely annoying.”*

*“**Notifications are aggravating.** Uninstall.”*

*“game is ok but it **keeps sending alerts even when i said not to**”*

*“**DO NOT DOWNLOAD. I am now receiving chinese telemarketing calls. They steal your information & more likely sell it.**”*

*“constant notifications on the middle of the night.”*

*“One star for sending a spam notification.”*

## **5.22 UI (User Interface)**

Users complain about user interface issues such as the UI buttons and labels not being displayed properly, overlapping UI components or poor UI formatting consisting of components that were cluttered and gaudy with icons in different places and styles. They also mention that UI is not user-friendly and needs to be improved in terms of design as well.

### **5.22.1 User Friendliness**

Customers complain of the drone app user interface not being user-friendly to use.

*“It is not user friendly and has a okay user interface but it needs too be fixed at some point”*

*“The drone is cool. The app is not. Its generally not a user friendly interface.”*

*“Very Laggy. Icons are not user friendly”*

### **5.22.2 Clarity**

Users also accuse few drone apps that the UI lacks proper organization and the icons seem cluttered and gaudy thus hindering usage of the app.

*“The UI got messed up. Its a mess. Unusable. The buttons are not recognizable, no labels, nothing.”*

*“Scrambled screen Everything works fine until I hit the challenge button and the screen is all scrambled. Please fix”*

*“First glance at the app, it seems cluttered and gaudy with icons in different places and style The idea being to present something visually appealing and easy to use. The main faults I see in this are that it deviates too much in style from the DJI Go 4 app, being the default user experience.”*

*“Terrible ui, hard to see where I can fly. Crash often. Slow and unresponsive. Only show flying status at current location or a particular address.”*

### 5.22.3 UI Errors

Users criticize UI errors.

*“Cant go thru step 3with this app when instaling the dro e for the first time. **Menu dont allow to go back or move forward to next step...**”*

*“Love the advertised features. I would be a commercial user but **the UI crash is forbidding use.**”*

*“Waste of money, dont work, **the control interface dont load.**”*

*“**Continuos UI error. Cleared cache and other actions.**”*

### 5.22.4 Display Issues

Some drone app users mention display problems such as the UI not fitting their mobile phone size i.e., the app does not resize according to display size. Few state text display errors and screen or picture deformity.

*“Changed rating. It continously crashes and says it **wont fit my display size on an android phone.** Needs fixed...I am not upgrading to another dji product if it doesnt get fixed.”*

*“Works fine for me but... **Text doesnt always display properly.** Cut off either horizontally, vertically or both.”*

*“Looking for vehicle Never connects. No problem connecting with Tower app.Pity, UI looks good from screenshots. Also, **app display does not support landscape mode on phones.**”*

*“Half the right eye screen is green and deformed”*

### 5.22.5 Poor Design

Users criticize a few drone apps because of their poor design. Some feedbacks also suggest that the app did not follow the required design guidelines.

*“Needs a better design. This looks too iOS-ish and buttons are really small. Also, 4PNTS functionality is on Snapseed for FREE. And I don't see enough things in this app that aren't on Snapseed already.”*

*“Poorly designed and difficult to use. This app was supposed to make it easy for drone/UAS operators to fly safely, but it's so frustrating to use that I doubt anyone will actually check it.”*

*“this app is a complete redo. it does not follow any Android recommended design guidelines, is slow and not responsive when switching between screens, and doesn't have a clear and guided user experience.”*

*“Very poor user interface. Extremely slow to load. Confusing to use.”*

### 5.23 Update Issues

This category occupies a major 12.49% of total complaints as shown in Figure 27. Users often complained that their app worked well until they updated it, which caused the app to stop functioning or has messed up some functionality (may have been caused by hardware or software incompatibility). The numerous complaints about the app being rendered unusable just after an update emphasizes the need for regressive testing before app update releases.

#### 5.23.1 Crashes after New Update

Many drone app users accuse of app crashes recently after they updated the app to the latest version.

*“Crashes on app load since last update. (Oneplus 2)”*

*“Worked before the up date but now it just crashes right away”*

*“ Since the latest update im finding the app crashes alot?”*

*“The application used to work fine till the last release. Now it crashes in mid flight. Please fix ASAP or roll back version.”*

### **5.23.2 Functional Errors after Updating**

Users also complain about functionality errors which were evident after the new app update.

*“Latest update causing my location caanot be forecasted. It said that fetching error. My location is in Jakarta, Indonesia.”*

*“Since 4.1.10 this has caused loss of picture, transmission errors etc. Stick to 4.1.8 until its sorted”*

*“This app is having some bug issues.. The display is going out for androids...becoming green n having grains while flying... The problem is seen after i update the app. When the second update came.. Its also having some this kinda errors.... Kindly do fix the bugs... So that we could shoot those visuals....”*

*“i used this app in the past and loved all the information it provided and how youre able to create a flight plan. But after updating it i always get the an error occurred while trying to complete the request. please try again. error. Infact i havent been able to create a single one yet. all my info is correct and verified. im on a galaxy s10+.”*

### **5.23.3 Loss of Data**

Many of the reviews from the game category complain about the complete loss of data and game progress after an update.

*“After recent update lost all my money, gold and progress...fix this asap”*

*“Since 4.1.10 this has caused loss of picture, transmission errors etc. Stick to 4.1.8 until its sorted”*

*“All previous Progress has been wiped out with the Update... Im not a happy chappy... :- (“*

*“After the update all my progress was deleted. Had to start all over. Pretty crappy”*

#### **5.23.4 Buggy Update/Bugs Not Fixed after Update**

While most reviews complain that the latest update has caused more bugs and users requesting the developers to roll up to the previous version, few criticize that the previously existing bugs were not fixed in the latest updates.

*“Great game while it works **but too many bugs after an update that prevents me playing** and tech support is next to non existent.”*

*“The **new update is full of bugs** now my camera is jittering on phone and my spark lost control for no reason fix it DJi”*

*“Bebop drone Took a few minutes to get the hang of it. The **drone isnt very stable after last update**, controls are simple and easy to use. What I dont like is there is no way to move the app from device memory to sd card. I have plenty of room in my memory, but would prefer it in the sd card. I try to sign up for drone academy, and it says no internet connection . **There are several bugs need to be fixed**”*

*“Disconnected **bug not fixed after update**. App used 40% of my xperia z1 battery overnight (it send somewhere 130mb of data also).”*

*“Buyers beware!!! With each update, there is a possibility that ur device will not be supported and you will be advised by support team to basically buy a new device. **The app since the update no longer works on my tablet and based on their response have no intention to fix the bug.**”*

### 5.23.5 Unable to Update

Some user feedbacks complain that they are unable to update their app to the new version.

*“App crashes every 2 minutes on my s7 edge. **I cant even update to the latest firmware** and i cant fly without the latest firmware. So Im pretty screwed.”*

*“Junk..opens to a yellow screen and thats all you get.. **if you cant update the app remove it from play store..** sheesh!”*

*“Constantly crashes and disconnects. **Cant update.** Dont understand why the developers havent fixed the android issues.”*

*“Used to work fine, **but lately doesnt update..**”*

### 5.23.6 Needs Update

Few people also complain that the app is very outdated and needs more updates to improvise it.

*“**needs an update** wont open on my phone”*

*“**Just needs an update.** The software keeps crashing especially when I try the follow me mode on it. Also it just needs more stability in general.”*

*“horrible experience. **this company needs to push updates to fix this connectivity issue** with the breeze. Will never recommend Yuneec products.”*

*“Has some serious connection issues. Video feed will work temporarily usually for a few seconds then will freeze. **App really needs an update**”*

### 5.24 Uninformative

These types of complaints could be just an appreciation of the app or extreme abuse, without providing any essential or useful information to the developer.



### 5.24.1 Appreciation

Most of the appreciation feedbacks were 3-star rated while a few had 1-star or 2-star rating. These could be mistaken ratings since the review statements were optimistic.

*“Intresting to play”*

*“Im enjoying the game at the same time learning how to play the game”*

*“Its a fun game. I play a lot . like the zoom in, daylight or dark mode, good graphics.”*

*“love it cool game”*

### 5.24.2 Criticism

While some people express sarcasm while reporting negative feedback, few abuse the developers for low-quality apps or for being unresponsive to queries.

*“This app should be pulled. My 7 yr old could code an app better than this. Hoping this is some high schoolers end of semester project. If it was I would be sure to fail them. Pathetic app.”*

*“Complete Rubbish Not much to do, only about three options. If youre looking for The Missing Link in High End Mobile Photography I suggest Google Snapseed. At least thats free.”*

*“fix your stupid app its completely unacceptable.”*

*“Ive honestly never encountered a worse piece of software in my life... drone is unusable.”*

### 5.25 Uninteresting Content

Users feel that the app has been hyped too much but in reality, it is not worth so much. They also mention that the app is too simple with barely a few features. They accuse that false advertisements that recommend installing some of the drone apps are very deceptive. A few feedbacks declare that the new app is the same as the previous app in the series of apps released by the same developer.

### 5.25.1 Hype

The app was hyped too much with false advertising. Some apps provided an extravagant app description or videos and pictures depicting features or functionalities that were not present in the app or containing a poor version of the features and functionalities described.

*“This is **false advertisement** you show a shooting game at the first that is teen times better than your game.”*

*“**False expectations** When they say sound recording not supported I was expecting video recording. Whole reason for buying this expensive app. Had also been recommended the easycap device and this app as a nice DVR. But that is however not developers fault”*

*“The old-school original Galaga graphics shown in the ad are nowhere to be found in the actual game. **Dont believe the hype and dont waste your time downloading this.**”*

*“Does NOT unlock any potential!!! **100% PURE HYPE.** See only 60% of dji app. Horrible resolution, useless for close proximity flying This app is NOT ready for prime time. GEAR VR video placement on 16:9 is waaaayyy too high. No way to adjust. You only see 60% of what you seen normally using dji app. This app is useless for anything other than flying around and getting panoramic shots. Good concept and swindled my \$20. I would NOT RECOMMEND this app.”*

*“**False advertising description** said could save videos and pictures for uploading to social networks or save to device to view later shouldve bought the hd drone w/sd”*

*“I think the material in the app is great, but it isnt nearly comprehensive enough The way the questions are asked in the actual exam are worded to be tricky rather than straight forward as they are in the app. I need to delve further into the FAA materials apparently.. I thought I was ready - guess not. **The in-app tests gave me a false security.**”*

### 5.25.2 Needs Better Content

The drone app users criticize that the app needs improvement.

*“Needs more improvements”*

*“Needs a lot more but still its an amazing game”*

*“needs alot of work”*

*“Alright, however the return to home feature doesnt work. Needs significant improvements.”*

### 5.25.3 Comparison to Other Apps

The drone app users compare the app to other apps available in the Google Play Store, mentioning that the free apps seem much better than the paid uninteresting ones.

*“What? Useless. **Gotten better performance from free apps**”*

*“Doesnt even match other maps... kind of scarey... uninstalled it pronto”*

*“horrible game. everything about it sucks. **download any of the other options.**”*

*“Dont waste your money **The free official app is way better...** total waste of money...”*

### 5.26 Unresponsive

Feedback about the app being unresponsive includes situations where the app freezes or the app stuck at the loading screen.

*“Im sure this would be a good all, if only it worked. **Slow, unresponsive.** Unforgivable in todays age... APP dev needs to rep from scratch.”*

#### 5.26.1 App Hangs/Freezes

Users also complain about the app hangs or app freezes that occurs mostly during the app start or while recording videos.

*“**App hangs up** once connected cannot see whats going on. fix this bug”*

*“The app constantly freezes its a pile of junk locked up wont report where youre at over and over and over again it just is a piece of junk that this is not working properly and would not recommend it to anyone”*

*“The video viewer sucks when I record a video it is bad quality it freezes up and it it in time lapse of the video never get this app”*

*“Maybe becaus of my new Android but the app wont start up. Hanging on the yellow openings screens”*

*“It does not work properly on my Xiaomi mi 4i (Snapdragon 615) with Mavic Pro. The video freezes. After a couple of minutes of flight, the connection is lost.”*

#### **5.26.2 Stuck at a Screen**

Most of the reviews in the unresponsive category mentioned that the app remained stuck at a yellow or black screen and failed to respond.

*“Does not work Tried on three devices one of them being bone stock with the only apps installed are free flight and this one I just get stuck at connecting screen.”*

*“i can not get passed the disclosure page. in horizontal i see the I Agree but then the screen goes vertical and i am stuck. eould like to use but cannot”*

*“Wont load stuck at white screen Was really looking forward to this apps capabilities however all I was able to was stare at a white screen on my nexus 6. Update to fix this, please!”*

*“The app is stuck at yellow screen the whole time and Im not even on a bad phone”*

*“Freeze Aftet updating to v2.0.17 app stuck on startup page.”*

#### **5.26.3 Loading Issues**

Users also complain about the app loading problems.

*“Game stuck at loading”*

*“Not working on my 2 smartphone..honor 10 and realme 3 pro...after i click agree ... **Game stuck and loading forever...can you tell me why?**”*

*“its doesnt work **the loading screen just keeps loading** then crashes cant play it”*

*“Not working **It wont get past the loading page!** it used to work ok!”*

## **5.27 Usability**

Reviews of this category complain that the app is not user-friendly such as being hard or overly complicated to use.

### **5.27.1 Complicated to Use**

Some drone apps were accused of being complicated and hard or confusing to use.

*“Meh **Overly complicated** for use when flying.”*

*“**Too hard!!! Too complicated!!!**”*

*“**Complicated Lousy**”*

*“**please.explain color codes..its difficult** to make a decision”*

*“Older version was much better I dont understand why developers make their **apps a lot more complicated and harder to use by adding so many useless features.** The older version of the app was much easier to use.”*

*“**App and Rules are confusing.** When i created flight path it shows no advisory but same time it shows list of rules. **App should be more user friendly and not complicated**”*

*“I want my money back! **is too damn hard to** connect my ph3 std. .. and **where in the heck is the record bottom?** what we need is a app that split the screen on are stock dji phantom 3 standard app .... thats it”*

*“Is there any way to Give less than a single star? **Can someone redo this app so that it works?**”*

***Confusing, slow, locks up, cant drop a pin in the same place twice, wont remember settings and***

*lists airports that have been gone for >20 years. Please help! I live in the NFZ outside DFW airport. Now it wont even show the restricted area around DFW. POS.*”

*“A little confused... Please explain the colour circles...? Thank you kindly..”*

### **5.27.2 User Friendliness**

A few drone app users complain that the app was not user-friendly.

*“Cannot connect to the dji rc,dun know why they design an app that not compatible with it,**not user friendly**...”*

*“Very disapointing Slow, buggy, **not user friendly at all**. It is my first Parrot drone and I had very high expectations.”*

*“Awful Experience, Chinese Incoherence, **Not User Friendly**”*

*“there. You tell me I need to call my local airport. What number? It says within this 5 mile radius I am still in class G. Could you give a link alongside this class indicating what it means? This is **not beginner friendly** and is far from close to what it should be, but you get an extra star for effort and creativity. Try harder next time. Doesnt take 1 million per year to fix it.”*

### **5.27.3 Lack of Instruction/Tutorials**

Certain feedbacks indicate that the drone app lacks instructions or tutorials on how to use the app. Some users even request a manual or tutorial to learn how to use the app with the drone.

*“Needs work Cant use free flight and **no instructions**”*

*“**Instructions are awful**. It says just press Start and there is no start button. **Cannot figure out how to fly**”*

*“Useful but not very intuitive **No labels to explain whats what, or a tutorial**. Could be better. Ive refunding for the time being, will revisit in future to see if any improvements have come along.”*

*“Needs a manual”*

*“Crashes mid flight. Where are your tutorials? You should mail or download link us instructions on this app.”*

## **5.28 Others**

Apart from the decided 27 categories of complaint types, some reviews mentioned issues that fell into the ‘others’ category, which will be discussed in this section. Users tend to accuse the app not being informative enough. In some reviews, users have requested tutorials describing the workflow of the app. Some users even request for trial versions or request offers in case of paid apps. Few feedbacks even question the trust or reliability of the app due to crashes or functional bugs, which are comprehensible since in some cases, the apps have caused fatal issues such as the phone turning off and not able to restart it (phone is bricked). Some feedbacks reveal that the users are reluctant to share personal information for login purposes. A number of apps also do not have support for all the drones, hence users have requested to add support for their drone types. Few controller apps ask for FAA certification of the user to allow the user to fly the drone. Users who wanted to just try for the first time complained about these requirements since they just wanted to fly the drone for fun. Few of the users had expected some features or functionality and were disappointed with the actual app, hence leaving low rating feedback. These expectations could be due to the hype created for the app. Thus, users also complain about false advertising stating that the videos or images or app description promises a lot but actually renders very less. The users also accuse the app developers of not paying heed to Android app issues while offering A1 class of service to iOS platform app users.

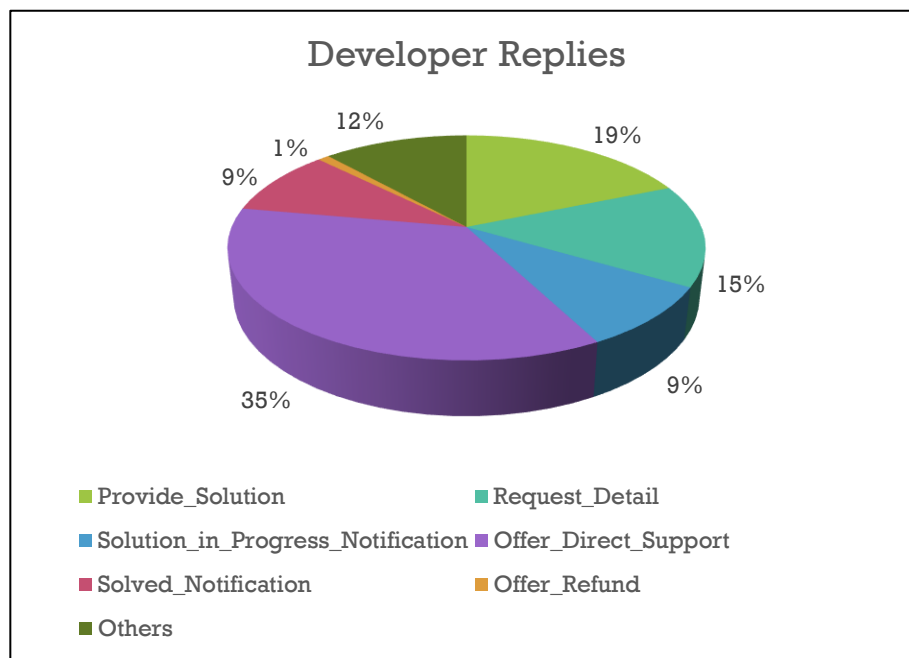
*“Maybe it was a coincidence but it seems **this app just bricked my phone**. My first gen Google Pixel, 128 gb was working fine until I downloaded the B4UFLY app. **A few minutes later the screen went black and the device will not power up**. I tried to reset it, and hard-resetting but*

*there nothing happens.”*

*“Its ok official app but the problem is the company stance on offering **iOS users an A1 class of service but android only gets a C3 grade service**. I have not had any disconnect issues reported by others but we get late updates for new features that iOS are already board with. Android users are treated as second class citizens in afraid.”*

*“still asks me for my **FAA 107** and a bunch of other stuff! **I just wanted to take a few pictures of a new office building** going up and its just barely in a red zone. no luck with this app unfortunately.”*

Among the developer replies, the most frequent reply types were offering direct support, providing a solution or requesting more details.



**Figure 28: Developer Reply Percentages per Type**

The Figure represents the distribution of developer replies across the defined 7 types.



## 5.29 Developer Replies

A short summary of the developer reply types is provided in this section. The percentages of developer replies according to their categories are depicted in Figure 28.

### 5.29.1 Provide Solution

The developer furnishes a number of steps for the user to follow in order to solve the issue. Often these types of responses are accompanied along with direct support mail contact information or forum links, asking the customer to revert back if the steps do not solve the issue in order to follow up on it. While some of the responses clarify why the app collects personal information while replying for the reviews where the users question as to why the app requires too much private information since they feel unsafe about it, others give justification for their in-app purchases, informing the users that the in-app purchases were mentioned in the app description and advises users to read it before installation or purchase.

*“In case of connectivity problems **please make sure no other DJI apps are running in the background.** To do so either restart your phone or go to the settings app / applications and terminate them (closing them with home button is not enough).”*

*“**Please try the below steps** and revert at [support@reliancegames.com](mailto:support@reliancegames.com) if the issue persists-*

*1 Kill/close the game and any unnecessary apps running in the background*

*2 Free up some space in the device/Clear game cache*

*3 Reboot/restart your device and launch the game in a strong network(WIFI)”*

### 5.29.2 Request Detail

Nearly 15% of the time developers ask the app users to provide more information about the problem encountered. Developers ask users to include details about their setup such as the

mobile device model, drone model (e.g., DJI drone model), firmware version (e.g., DJI firmware version), app version, etc. Some developers ask functionality queries like: is the user able to launch the app, go past the start-up screen or is the app freezing while doing so? in order to troubleshoot. Few also queried whether the issues happened after an update. A few replies also ask users to send all the crash logs while some have asked to send screenshots or videos when the issue had occurred. The developers have also asked some users to report their issue to the community forum page or customer care email id or their technical support department call facility along with all the device and software version details. For the users who have requested a refund, developers have asked their request order number to initiate the refund process whereas, for the reviews that have mentioned that the app needs more improvement, developers request a detailed or more specific suggestion to be sent to their support email. Some replies ask the users to try on a different device and report the results to them.

*“Hello, please contact [support@flylitchi.com](mailto:support@flylitchi.com) so we can help you. **Make sure to include details about your setup** (mobile device model, DJI drone model, DJI firmware version, Litchi version).”*

*“Thank you for advising of the experience you encountered Stefanos. We are currently investigating into this occurrence with your device specifications. **But if you would be able to provide any screenshots of any error message or disconnected status in the application, please email [support@airmap.com](mailto:support@airmap.com)!**”*

### **5.29.3 Solution in Progress Notification**

Developers replied to inform the users that their engineers are investigating the issue and a solution to it is in progress (9% responses are of this category). Most of the replies state that the next update will fix the issue reported in the user feedback. While the reviews that suggested to

add support for more drone models were responded that they would consider supporting additional drone models in the next app update, for device incompatibility too, the developers answered that they could add compatibility for additional devices or Android OS versions in future updates. As a response to new feature addition proposals, the developers acknowledged the customers for their valuable feedback and stated that the development team is actively working in the feature addition or would consider their recommendations as they constantly strive to improve their game. As for bug fixes, developers apologized for the delay and have requested users to kindly extend their patience and follow up until the issue is resolved. In case of the excessive advertisement complaints, they responded that the concerned team is being notified to resolve it.

*“Thank you for your feedback. **The question is under investigation.**”*

*“Hello,*

*We do apologize for any inconvenience. We already reported the compatibility and crash issue to the development team, and they are **working right now on the application to resolve the issue as soon as possible.***

*Kindly extend your patience.*

*Best Regards,*

*Parrot Community Support.”*

#### **5.29.4 Offer Direct Support**

As a response to negative user feedback, most of the developers offer direct support (35%) such as providing the option to report the issue technical support mail id (e.g., support@flylitchi.com) or phone number or a support forum community page Falcon Squad

community page (e.g., <https://www.facebook.com/spacewargame>) which was a game app support page or website (e.g., <https://www.parrot.com/support/hotline>) where the user can report their issue with details to the support executive and receive immediate solutions to their issues. Some have also asked users to contact them directly in order for the developers to guide them on how to use certain features of the app and also for the users to provide some new suggestions. In cases where the users often complained of purchase and stated that they did not receive it, they were apologized for the unpleasant experiences and were advised to contact the support team directly through mail or call and mention their order number in order to proceed in helping them. If the purchased feature is not working, users were asked to simply reject the order. Some responses asked the user to mail the developer directly through the contact details provided instead of reporting app issues in the Google Play Store platform. Few users were advised to go through FAQ available on their website and if it does not resolve the issue, then contact technical support directly.

*“Please contact [support@flylitchi.com](mailto:support@flylitchi.com) so we can help you fix this.”*

*“Hello, users, you can consult. [jov@simtoo.com](mailto:jov@simtoo.com) Thank you~”*

### **5.29.5 Offer Refund**

A very meager percentage of only 1% of the developer responses offer a full refund to the users who are dissatisfied with the app. In some review, users have complained that they did not receive a refund. As a response to these types of reviews, the developers have asked the users to provide their order number or transaction id since they would not be able to initiate a refund without it, while a few asked for the purchase receipt to be sent to the support mail id. Some reviews which were offered refund were for education apps where the discontented user reports that the practice questions provided in the app were not helpful and resulted in the user failing

the drone pilot exams. Few responses asked users to directly contact a tech support email id to further proceed with the refund. In the case of device incompatibility issues, the developer apologizes to the customer, offering a refund and justifies that it is impossible to provide support for all the varieties of drones or devices present in the market. For a few 1-star reviews, the developer responds that if the app is so dissatisfying to receive such a bad rating, then they are happy to issue a refund. Some developers have offered direct support, requesting the users to send the details of the issue so that they can work on it, failing which they were offering to issue a full refund.

*“One star? If its that bad send me an email. **More than happy to issue a refund.**”*

*“Please contact us at [support@applogics.com](mailto:support@applogics.com) and **we can help you with issues or refund.**”*

#### **5.29.6 Solved Notification**

The developer notifies the user that the issue mentioned in their negative feedback has been solved. Only 9% of responses belong to this category which implies that either developer does not solve issues actively or they take too long to respond, or they do not notify even after solving the bugs. While most of the solved notifications mention that the problem was solved in an update and the user has to upgrade to the new version for it to reflect, a handful responds that the maintenance has solved the issue and just a logout & login will display the new changes. Some responses advise users that the issue is present only in the old version of Android OS and an Android OS update will resolve it. Few app developers have added support for new drone models or new phone compatibilities as requested by the user and notified them of the update. A small number of responses apologize for service outage and notify that the service has rebounded once again. The developers have also expressed regret for the delay in responses since the app improvisation was a major update.

*“Thanks for your review. There was a bug. **I just uploaded an update (version 2.4.1) which fixes it again.**”*

*“We appreciate your patience during this fix Chris. **I am happy to report that the AirMap application is currently functioning properly** and displaying airspace information when selecting a particular gridded area for recreational and commercial operators. Fly Safe!”*

#### **5.29.7 Others**

Almost 12% of the developer responses did not belong to the above mentioned 6 categories. For most of the good reviews in 3-star rating comments which did not specifically mention any complaints but just appreciated the app, the developer just expresses their gratitude and prompts or requests their users to give their app a 5-star rating. Some responses state that the issue has been caused not by the app but due to an OS update or a phone hardware problem. For cost complaint types, very few developers have advised them to reject the order if they are unsatisfied. In case of harsh reviews, while some developers responded politely apologizing for the inconvenience caused (such as by the Parrot SA developer) some others gave cold or sarcastic responses, and a few listed out the app’s positive features with the motive of giving justification for their app credibility. A couple of responses even complain that the users have not responded to developer queries or that the user’s expectation is very high. On the other hand, few developers express regret for the user’s low ratings. Some developers accused competitors of giving false negative reviews to belittle their apps. They accuse so because the feedback complains about a feature that is nonexistent in the app. Developers also justify the in-app purchase cost or annoying advertisements by politely stating that this was required for economic reasons. A handful of responses apologize for disrupted service in weather apps due to weather service undergoing maintenance, hence not being able to support some functionality (service

outage). While some developers reject reviewer's suggestions to add features and refer to using other apps in order to have the mentioned functionalities, some developers request users to share their ideas to improve the app.

### **5.30 Most Frequent Complaints**

While analyzing user reviews, it is essential to determine the most frequently occurring complaint. The percentage of all 27 complaint types across all 66 apps was calculated and the median among them is assigned to each complaint type. This median selection eliminates the bias that may have occurred due to a greater number of reviews in certain apps. On inspecting the results obtained, it is found that the Functional Error (27.9%), Device Compatibility (16.8%), Cost (16.2%) and Connection/Sync (15.6%) are the most frequently occurring Complaints while Feature Removal (0.8%), Spam Notification (0.8%), and Missing Notification (0.8%) are the least frequently occurring complaint types as seen in Table 7. The rank column indicates the ranking of the user review complaint type when sorted in descending order according to the complaint type category having the highest number of complaints.

**Table 7: Most Frequent Complaints**

The table displays the most frequently occurring complaint type. It is ordered in decreasing order of frequency and the Rank provides the ranking position of the complaint type in terms of frequency.

<b>ComplaintType</b>	<b>Percentage</b>	<b>Rank</b>
Functional_Error	27.91792	1
Device_Compatibility	16.80791	2
Cost	16.25	3
ConnectionSync	15.625	4
Performance	11.46215	5
App_Crash	11.09523	6
Update_Issues	10.01112	7
Lack_of_Functionality	9.18463	8
UI_Other	8.931419	9
Unresponsive	7.692308	10
Uninformative	6.723164	11
Uninteresting_Content	6.723164	12
Feature_Request	6.25	13
Usability	5.825792	14
Customer_Support	5.405405	15
Additional_Cost	5	16
Network_Problem	4.456825	17
Resource_Heavy	4.395604	18
Battery	3.980152	19
Advertisements	3.333333	20
Installation_Problems	2.325896	21
Privacy_Ethical	2.298851	22
Device_Storage	1.351351	23
Cellular_Data_Usage	0.906344	24
Feature_Removal	0.843797	25
Spam_Notification	0.807292	26
Missing_Notification	0.803213	27



### 5.31 Negative Impact Ratio

**Table 8: Negative Impact Ratio**

The table shows the negative impact ratio of each complaint type. The higher the impact ratio, conveys that the complaint type has affected the drone app users more and the Rank provides the ranking position of the complaint type in terms of Impact Ratio.

Complaint Type	Impact Ratio	Rank
Uninformative	4.40	1
Device_Compatibility	3.91	2
Cost	3.80	3
Unresponsive	3.33	4
Privacy_Ethical	3.25	5
App_Crash	3.00	6
ConnectionSync	3.00	7
Customer_Support	3.00	8
Installation_Problems	3.00	9
Update_Issues	3.00	10
Uninteresting_Content	3.00	11
Functional_Error	2.67	12
Network_Problem	2.50	13
Additional_Cost	2.00	14
Lack_of_Functionality	2.00	15
UI_Other	2.00	16
Usability	2.00	17
Resource_Heavy	1.80	18
Spam_Notification	1.80	19
Battery	1.67	20
Performance	1.50	21
Advertisements	1.00	22
Cellular_Data_Usage	1.00	23
Device_Storage	1.00	24
Feature_Removal	1.00	25
Feature_Request	1.00	26
Missing_Notification	0.80	27

Furthermore, the potential negatively impacting complaint types were also examined. The most negatively impacting complaint types can deter the success of an app in the market.

The most frequent complaints may not necessarily be the most negatively impacting the users. To study the negative impact, the same methodology used by Mujahid et al. (2018) [35] was followed in the thesis. The ratio of 1-star to-2-star reviews for each complaint type was calculated, on a per-app basis. Finally, the median score from across all the apps to the specific complaint type was assigned and ranked based on their median score from 1 to 27 where 1 is the highest impactful and 27 is the least impactful. It can be seen from Table 8 that the most negatively impacting complaint type seems to be Uninformative Category which implies that the bad reviews or abusive reviews that contain no information of the issue that can serve useful to the developer, but just contain negative feedback about the app being bad, tend to have the highest of 1-star: 2-star rating ratio.

### **5.32 Types of Complaints Developer Reply To**

The Google Play Store also provides the developers with the ability to reply to user reviews such as providing a solution or request for more details regarding the issue faced. Therefore, the developer replies were analyzed to discover the user complaint types that the developers are most concerned with. Augmenting our user complaint data with their respective developer replies provides a 2D view of the complaints that both users and developers care about. From the table, it is observed that Functional Error, Cost, and Device Compatibility are the top three most replied-to complaint types which are also the most frequently occurring complaints. Thus, it can be observed that developers have replied to the most frequently occurring complaints. Table 9 shows the rank and median percentage value of the developer reply for the different complaints.

**Table 9: Complaints significant to Developers**

The table demonstrates the frequently replied to complaint categories. The higher the percentage means the more frequent responses have been given to that complaint type and the Rank provides the ranking position of the complaint type in terms of frequent responses.

<b>Complaint Type</b>	<b>Percentage</b>	<b>Rank</b>
Functional_Error	40.91	1
Cost	33.33	2
Device_Compatibility	23.08	3
ConnectionSync	16.00	4
Performance	12.50	5
UI_Other	11.43	6
Update_Issues	11.43	7
Lack_of_Functionality	11.11	8
Unresponsive	9.55	9
App_Crash	9.09	10
Uninformative	8.33	11
Customer_Support	7.81	12
Uninteresting_Content	6.87	13
Usability	6.72	14
Feature_Request	6.67	15
Privacy_Ethical	5.88	16
Additional_Cost	5.56	17
Spam_Notification	5.56	18
Advertisements	5.00	19
Battery	4.55	20
Installation_Problems	4.55	21
Network_Problem	4.17	22
Resource_Heavy	3.13	23
Device_Storage	2.08	24
Missing_Notification	1.67	25
Cellular_Data_Usage	1.53	26
Feature_Removal	1.43	27

### 5.33 Reply Time per Complaint Type

**Table 10: Developer Response Time**

The table shows the Developer Response days. The lesser the response time, the higher the importance given, and it is sorted according to increasing order of the complaint type in terms of reply time.

Complaint Type	Percentage	Rank
Additional_Cost	0	1
Battery	0	2
Customer_Support	0	3
Device_Storage	0	4
Feature_Removal	0	5
Update_Issues	0.5	6
Cost	1	7
Network_Problem	1	8
Privacy_Ethical	1	9
Lack_of_Functionality	1.2	10
Resource_Heavy	1.5	11
Advertisements	1.67	12
Performance	1.71	13
ConnectionSync	2	14
Feature_Request	2	15
Installation_Problems	2	16
Missing_Notification	2	17
Spam_Notification	2	18
Uninformative	2	19
Uninteresting_Content	2	20
Unresponsive	2	21
App_Crash	3	22
Functional_Error	3	23
UI_Other	3.4	24
Usability	3.5	25
Cellular_Data_Usage	6	26
Device_Compatibility	6	27

Table 10 lists the median of the number of days taken for the developers to reply to the reviews of each particular complaint type. It is seen that the complaint types Additional Cost, Battery and Customer Support and a few more have a median of zero, meaning that the developer replied on the same day that these review complaint types were posted. Some other types such as Update Issues, Cost, Network Problem, and Privacy Ethical also have very less response time (less or equal to a day). It is important to note that although Functional Error is the most replied to type of complaint, it is not necessarily the type with the fastest response from the developer.

As perceived from Table 10, it is clear that the number of days for the developer to respond to customer complaints does not exceed 6 days on an average. Even though this is the case, very few reviews had a review response time delay spanning to even greater than months, the greatest in the thesis dataset being from feature request and uninteresting content with a span of 17 months and 19 months respectively.

## **CHAPTER 6**

### **CONCLUSION & FUTURE WORK**

#### **6.1 Threat To Validity**

The Threats to the Validity of this thesis are discussed below. The Threats are External Validity, Internal Validity and Construct Validity.

##### **6.1.1 External Validity**

###### **6.1.1.1 Limited drone apps**

The thesis analyzes Android apps because there are readily available APIs to mine the Google Play store. The study was performed on 1825 drone mobile apps and from the app store visible to US customers only. Hence, the results about complaints may not be generalized to all the Android apps in the Google app store. To mitigate this threat the coverage of complaints was maximized by studying drone-related apps covering most of the categories in the App Store.

###### **6.1.1.2 Selection Of Apps and Reviews**

The selection of mobile apps excluded, by necessity, mobile apps with a lesser number of downloads and reviews. Also, the reviews of 4-star and 5-star ratings were eliminated since the thesis focuses only on negative feedback to study what users complain about drone apps. Therefore, it is unclear how the thesis results will generalize to all types of mobile apps.

##### **6.1.2 Internal Validity**

###### **6.1.2.1 Accuracy of the crawling API**

Publicly available APIs were used to mine the Google Play market. The crawling tools collected the data from the store automatically. Although every possible step was taken to ensure

the correct working of the tools, it is not possible to thoroughly evaluate the accuracy of the crawling API.

### **6.1.2.2 Manual Tagging**

The reviews of the drone app are tagged manually into their respective complaint types. During this process, human error or subjectivity may have led to incorrect tagging. This threat was addressed by random inspection of the reviews and the corresponding tags by the second and third authors of this article.

### **6.1.3 Construct Validity**

#### **6.1.3.1 Rating Prospect**

The thesis study used the user assigned ratings of apps (appscore) for app selection. In order to remove bias of free and paid apps or the app score rating, 2 apps from each of the following four categories were selected: a) free apps with appscore of less than 3.5, b) free apps with appscore of greater than 3.5, c) paid apps with appscore of less than 3.5, d) paid apps with appscore of greater than 3.5. Due to the lack of paid apps in a few app categories, the resulting dataset consisted of a greater number of free apps by a meager margin.

Although a Drone app might be of high quality from the developer's perspective, if the drone app does not have attractive features, generates too many ads or behaves poorly compared to a competitor, it might have a poor rating. Furthermore, users might rate an app negatively on purpose or might neglect to rate an app because they are extremely happy or unhappy. Finally, only a small number of people might rate a particular app, yielding a relatively unreliable rating. Since the thesis filtered out apps with a too low number of versions or raters, the effect of a few anomalous raters should be dealt with.

### **6.1.3.2 Identifying Stakeholders of Complaints**

Since users review apps as a whole, they often raise issues that are not directly the responsibility of the developers; some complaints are directed towards product managers or other team members. For example, some issues are related to the Developers of Drone apps. Developer complaints are those that are directly related to development issues. These issues include ‘Apps Crashing,’ ‘Functional Error,’ ‘Network Problem,’ ‘Resource Heavy,’ and ‘Unresponsive App’ complaints. Strategic issues are complaints that primarily concern project managers but could, partially target developers as well. These issues include ‘Feature Removal,’ ‘Feature Request,’ ‘Interface Design’ and ‘Compatibility’ complaints. Content issues encompass complaints about the content or value of the app itself – developers have little or no control over these issues. These issues include ‘Privacy and Ethical,’ ‘Hidden Cost’ and ‘Uninteresting Content’ complaints. Addressing these issues requires rethinking the core strategy of the app (i.e., business model or the content offered). The thesis does not identify the stakeholders and categorize the drone app user complaints accordingly.

### **6.1.4 Conclusion**

Within the past few years, there has been a tremendous increase in the number of UAVs (Unmanned Aerial Vehicle) or drones manufactured and purchased, which is expected to proliferate further, penetrating into every stream of life, thus making its usage inevitable. The UAV’s major components are its physical hardware and programming software, which controls its navigation or performs various tasks based on the field of concern. The drone manufacturers launch the controlling app for the drones in mobile app stores. A few drone manufacturers also release development kits to aid drone enthusiasts in developing customized or more creative apps. Thus, the app stores are also expected to be flooded with drone-related apps in the near



future. With various active research and studies being carried out in UAV's hardware field, no effort is dedicated to studying/researching the software side of UAV. This thesis is a large-scale empirical study of UAV or drone-related apps of the Google Play Store Platform. The study consisted of 1,825 UAV mobile apps, across twenty-five categories, with 162,250 reviews. Some of the notable findings of the thesis are (a) There are 27 major types of issues the drone app users complain about. The 27 complaint types of drone-related apps are: *Additional\_Cost* - The user complains not about game cost, but about hidden additional costs in various levels of the game, *Advertisements* - The user complains about advertisements while using the app, *App\_Crash* - The user complains about app crashes, *Battery* - The user complains about the battery drain, *Cellular\_Data\_Usage* - The user complains about heavy data usage by the app, *ConnectionSync* - The user complains about connectivity or syncing problems with the drone, *Cost* - The user complains about app costs, *Customer\_Support* - The user complains about customer support response delay or being unhelpful, *Device\_Compatibility* - The user complains about the app not being compatible with their phone's OS or hardware, *Device\_Storage* - The user complains about storage problems, *Feature\_Removal* - The user suggests removing a feature from the app, *Feature\_Request* - The user requests to add a new feature to the app, *Functional\_Error* - The user complains about any error in the functioning of the app, *Installation\_Problems* - The user complains about app installation issues, *Lack\_of\_Functionality* - The user complains about the lack of functionality, *Missing\_Notification* - The user complains about missing notification, *Network\_Problem* - The user complains about network issues, *Performance* - The user complains about app performance - slow or lags, video or picture quality, *Privacy\_Ethical* - The user complains about privacy intrusion or ethical/legal issues, *Resource\_Heavy* - The user complains about CPU or memory usage, *Spam\_Notification* - The user complains about

unwanted notifications, *UI* - The user complains about user interface (UI), *Update\_Issues* - The user complains about app malfunction after certain version updates, *Uninformative* - Either good review or bad abusive review but with no information useful to the developer, *Uninteresting\_Content* - The user complains about the app being hyped too much but is a very simple app in reality with not much interesting content, *Unresponsive* - The user complains about app freezing or unresponsive and *Usability* - The user complains about how the app is confusing and hard to use. (b) The top four complaints observed are Functional Error (27.9%), Device Compatibility (16.8%), Cost (16.2%) and Connection/Sync (15.6%). (c) The top four issues for which the UAV manufacturers, or Drone app developers provide feedback to user complaints are Functional Error (40.9%), Cost (33.3%), Device Compatibility (23.1%), and ConnectionSync (16%). (d) Developers respond to the most frequently occurring complaints rather than the most negatively impacting ones.

## **6.2 Future Work**

The thesis proposes to accomplish the following tasks in the future: a) identifying the stakeholders of the reviews and perform review analysis on the individual stakeholder perspective, b) perform similar review analysis on UAV or drone-related apps of other mobile app platforms such as the iOS store, Blackberry World, and c) Apply machine learning on the manually categorized user reviews dataset to enable the automatic classification of upcoming new user feedback into their respective complaint types, since it is a tedious process to classify the reviews manually.

## REFERENCES

- [1] Abad, Z. S. H., Sims, S. D. V., Cheema, A., Nasir, M. B., & Harisinghani, P. (2017). Learn more, pay less! Lessons learned from applying the wizard-of-oz technique for exploring mobile app requirements. *Proceedings - 2017 IEEE 25th International Requirements Engineering Conference Workshops, REW 2017*, (13), 132–138. <https://doi.org/10.1109/REW.2017.71>
- [2] Android Apps on Google Play. (n.d.). Retrieved from <https://play.google.com/store/apps/>
- [3] App stores: number of apps in leading app stores 2019 | Statista. (n.d.). Retrieved November 20, 2019, from <https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>
- [4] Apple: most popular app store categories 2019 | Statista. (n.d.). Retrieved November 20, 2019, from <https://www.statista.com/statistics/270291/popular-categories-in-the-app-store/>
- [5] Corrigan, F. (2019, November 9). 12 Top Drones With Excellent Cameras, GPS, Autopilot And Low Prices. Retrieved November 20, 2019, from <https://www.dronezon.com/drone-reviews/drone-gps-autopilot-at-very-affordable-prices/>.
- [6] Dalpiaz, F., & Parente, M. (2019). RE-SWOT: From User Feedback to Requirements via Competitor Analysis. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 11412 LNCS, 55–70. [https://doi.org/10.1007/978-3-030-15538-4\\_4](https://doi.org/10.1007/978-3-030-15538-4_4)
- [7] Day, M. Y., & Lin, Y. Da. (2017). Deep learning for sentiment analysis on google play consumer review. *Proceedings - 2017 IEEE International Conference on Information Reuse and Integration, IRI 2017*, 2017-Janua(39), 382–388. <https://doi.org/10.1109/IRI.2017.79>
- [8] Di Sorbo, A., Panichella, S., Alexandru, C. V., Visaggio, C. A., & Canfora, G. (2017). SURF: Summarizer of user reviews feedback. *Proceedings - 2017 IEEE/ACM 39th International Conference on Software Engineering Companion, ICSE-C 2017*, (i), 55–58. <https://doi.org/10.1109/ICSE-C.2017.5>
- [9] Facundoolano. (2019, November 19). [facundoolano/google-play-scraper](https://github.com/facundoolano/google-play-scraper). Retrieved from <https://github.com/facundoolano/google-play-scraper>.
- [10] Finkelstein, A., Harman, M., Jia, Y., Martin, W., Sarro, F., & Zhang, Y. (2017). Investigating the relationship between price, rating, and popularity in the Blackberry World App Store. *Information and Software Technology*, 87, 119–139. <https://doi.org/10.1016/j.infsof.2017.03.002>
- [11] French drone maker Parrot selected to develop spy aircraft for the US military - The Verge. (n.d.). Retrieved November 20, 2019, from <https://www.theverge.com/2019/5/28/18642728/parrot-drones-us-military-department-of-defense-contract-china-dji>
- [12] Fu, B., Lin, J., Li, L., Faloutsos, C., Hong, J., & Sadeh, N. (2013). Why people hate your app. *Proceedings of the 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining - KDD '13*, 1276. <https://doi.org/10.1145/2487575.2488202>

- [13] Galov, N. (2019, October 24). 61 Internet Statistics and Facts that Prepare You for 2019. Retrieved from <https://hostingtribunal.com/blog/internet-statistics/#gref>.
- [14] Gao, C., Zeng, J., Lyu, M. R., & King, I. (2018). Online app review analysis for identifying emerging issues. 2018 IEEE/ACM 40th International Conference on Software Engineering (ICSE), (21), 48–58. <https://doi.org/10.1145/3180155.3180218>
- [15] Google Play - Wikipedia. (n.d.). Retrieved November 20, 2019, from [https://en.wikipedia.org/wiki/Google\\_Play](https://en.wikipedia.org/wiki/Google_Play)
- [16] Google Play Store: number of apps 2019 | Statista. (n.d.). Retrieved November 20, 2019, from <https://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store/>
- [17] Greenheld, G., Savarimuthu, B. T. R., & Licorish, S. A. (2018). Automating developers' responses to app reviews. Proceedings - 25th Australasian Software Engineering Conference, ASWEC 2018, (41), 66–70. <https://doi.org/10.1109/ASWEC.2018.00017>
- [18] Guzman, E., & Maalej, W. (2014). How do users like this feature? A fine grained sentiment analysis of App reviews. 2014 IEEE 22nd International Requirements Engineering Conference, RE 2014 - Proceedings, (1), 153–162. <https://doi.org/10.1109/RE.2014.6912257>
- [19] Ha, E., & Wagner, D. (2013). Do Android users write about electric sheep? Examining consumer reviews in Google Play. 2013 IEEE 10th Consumer Communications and Networking Conference, CCNC 2013, 149–157. <https://doi.org/10.1109/CCNC.2013.6488439>
- [20] Harman, M., Jia, Y., & Zhang, Y. (2012). App Store Mining and Analysis: MSR for App Stores. Retrieved from [www.cs.ucl.ac.uk/staff/Y.Jia/projects/app](http://www.cs.ucl.ac.uk/staff/Y.Jia/projects/app)
- [21] Hassan, S., Bezemer, C. P., & Hassan, A. E. (2018). Studying Bad Updates of Top Free-to-Download Apps in the Google Play Store. IEEE Transactions on Software Engineering, PP(23), 1. <https://doi.org/10.1109/TSE.2018.2869395>
- [22] Hassan, S., Tantithamthavorn, C., Bezemer, C. P., & Hassan, A. E. (2018). Studying the dialogue between users and developers of free apps in the Google Play Store. Empirical Software Engineering, 23(3), 1275–1312. <https://doi.org/10.1007/s10664-017-9538-9>
- [23] How Important are App Ratings and Reviews to Users? (n.d.). Retrieved November 20, 2019, from <https://blog.appsee.com/how-important-are-app-ratings-and-reviews-to-users/>
- [24] Hu, H., Bezemer, C.-P., & Hassan, A. E. (2018). Studying the consistency of star ratings and the complaints in 1 & 2-star user reviews for top free cross-platform Android and iOS apps. doi: 10.7287/peerj.preprints.2589v1
- [25] Hu, H., Wang, S., Bezemer, C. P., & Hassan, A. E. (2019). Studying the consistency of star ratings and reviews of popular free hybrid Android and iOS apps. Empirical Software Engineering, 24(1), 7–32. <https://doi.org/10.1007/s10664-018-9617-6>
- [26] Importance of Mobile App Reviews for Your Business. (n.d.). Retrieved November 20, 2019, from <https://www.mobileappdaily.com/2018/10/30/mobile-app-review-importance>

- [27] Interesting Mobile App Market Statistics for 2019. (n.d.). Retrieved November 20, 2019, from <https://lvivity.com/mobile-app-statistics-for-2019>
- [28] Islam, M. R. (2014). Numeric rating of Apps on Google Play Store by sentiment analysis on user reviews. 1st International Conference on Electrical Engineering and Information and Communication Technology, ICEEICT 2014, (2), 1–4. <https://doi.org/10.1109/ICEEICT.2014.6919058>
- [29] Jha, N., & Mahmoud, A. (2018). Using frame semantics for classifying and summarizing application store reviews. In Empirical Software Engineering (Vol. 23). <https://doi.org/10.1007/s10664-018-9605-x>
- [30] Khalid, H. (2013). On identifying user complaints of iOS apps. Proceedings - International Conference on Software Engineering, 1474–1476. <https://doi.org/10.1109/ICSE.2013.6606749>
- [31] Khalid, H., Shihab, E., Nagappan, M., & Hassan, A. E. (2015). What do mobile app users complain about? IEEE Software, 32(3), 70–77. <https://doi.org/10.1109/MS.2014.50>
- [32] Kim, H.W., Lee, H.L., and Son, J. (2011). An exploratory study on the determinants of smartphone app purchase. In The 11th International DSI and the 16th APDSI Joint Meeting.
- [33] Raja, D.R., & Pushpa, S. (2019). Diversifying personalized mobile multimedia application recommendations through the Latent Dirichlet Allocation and clustering optimization. Multimedia Tools and Applications, 1-20.. (2019). Diversifying personalized mobile multimedia application recommendations through the Latent Dirichlet Allocation and clustering optimization. Multimedia Tools and Applications. <https://doi.org/10.1007/s11042-019-7190-7>
- [34] Lai, Y. H., Huang, F. F., & Chiou, P. Y. (2018). Analysis of user feedback in the mobile app store using text mining: A case study of Google Fit. Proceedings - 2017 IEEE 8th International Conference on Awareness Science and Technology, ICAST 2017, 2018-Janua(15), 50–54. <https://doi.org/10.1109/ICAwST.2017.8256508>
- [35] Mujahid, S., Sierra, G., Abdalkareem, R., Shihab, E., & Shang, W. (2018). An empirical study of Android Wear user complaints. Empirical Software Engineering, 23(6), 3476–3502. doi: 10.1007/s10664-018-9615-8
- [36] Malavolta, I., Ruberto, S., Soru, T., & Terragni, V. (2015). End Users' Perception of Hybrid Mobile Apps in the Google Play Store. Proceedings - 2015 IEEE 3rd International Conference on Mobile Services, MS 2015, (5), 25–32. <https://doi.org/10.1109/MobServ.2015.14>
- [37] Martin, W., Sarro, F., Jia, Y., Zhang, Y., & Harman, M. (2017). A survey of app store analysis for software engineering. IEEE Transactions on Software Engineering, 43(9), 817–847. <https://doi.org/10.1109/TSE.2016.2630689>
- [38] McIlroy, S., Ali, N., Khalid, H., & E. Hassan, A. (2016). Analyzing and automatically labelling the types of user issues that are raised in mobile app reviews. Empirical Software Engineering, 21(3), 1067–1106. <https://doi.org/10.1007/s10664-015-9375-7>

- [39] McIlroy, S., Shang, W., Ali, N., & Hassan, A. E. (2017). Is It Worth Responding to Reviews? Studying the Top Free Apps in Google Play. *IEEE Software*, 34(3), 64–71. <https://doi.org/10.1109/MS.2015.149>
- [40] Monett, D., & Stolte, H. (2016). Predicting star ratings based on annotated reviews of mobile apps. *Proceedings of the 2016 Federated Conference on Computer Science and Information Systems, FedCSIS 2016*, 8(9), 421–428. <https://doi.org/10.15439/2016F141>
- [41] Mudambi, Susan & Schuff, David. (2010). What Makes a Helpful Online Review? A Study of Customer Reviews on Amazon.com.. *MIS Quarterly*. 34. 185-200. 10.2307/20721420. <https://doi.org/10.2307/20721420>
- [42] Nayebi, M., Cho, H., & Ruhe, G. (2018). App store mining is not enough for app improvement. In *Empirical Software Engineering* (Vol. 23). <https://doi.org/10.1007/s10664-018-9601-1>
- [43] Noei, E., Zhang, F., & Zou, Y. (2019). Too Many User-Reviews, What Should App Developers Look at First? *IEEE Transactions on Software Engineering*, PP(28), 1–1. <https://doi.org/10.1109/tse.2019.2893171>
- [44] Pagano, D., & Maalej, W. (2013). User feedback in the appstore: An empirical study. *2013 21st IEEE International Requirements Engineering Conference, RE 2013 - Proceedings*, (March), 125–134. <https://doi.org/10.1109/RE.2013.6636712>
- [45] Regulation of UAVs in the United States - Wikipedia. (n.d.). Retrieved November 20, 2019, from [https://en.wikipedia.org/wiki/Regulation\\_of\\_UAVs\\_in\\_the\\_United\\_States](https://en.wikipedia.org/wiki/Regulation_of_UAVs_in_the_United_States)
- [46] Sample Size Calculator - Confidence Level, Confidence Interval, Sample Size, Population Size, Relevant Population - Creative Research Systems. (n.d.). Retrieved November 20, 2019, from <https://www.surveysystem.com/sscalc.htm>
- [47] Srisopha, K., & Alfayez, R. (2018). Software quality through the eyes of the end-user and static analysis tools: A study on Android OSS applications. *Proceedings - International Conference on Software Engineering*, (20), 1–4. <https://doi.org/10.1145/3194095.3194096>
- [48] Stock Images, Royalty-Free Pictures, Illustrations & Videos - iStock. (n.d.). Retrieved from <https://www.istockphoto.com/>
- [49] Tong, G., Guo, B., Yi, O., & Zhiwen, Y. (2018). Mining and analyzing user feedback from app reviews: An econometric approach. *Proceedings - 2018 IEEE SmartWorld, Ubiquitous Intelligence and Computing, Advanced and Trusted Computing, Scalable Computing and Communications, Cloud and Big Data Computing, Internet of People and Smart City Innovations, SmartWorld/UIC/ATC/ScalCom/CBDCom*, (26), 841–848. <https://doi.org/10.1109/SmartWorld.2018.00155>
- [50] U.S. Consumers Time-Spent on Mobile Crosses 5... | Flurry Blog. (n.d.). Retrieved November 20, 2019, from <https://www.flurry.com/post/157921590345/us-consumers-time-spent-on-mobile-crosses-5>
- [51] Wang, M., & Li, X. (2017). Effects of the aesthetic design of icons on app downloads: evidence from an android market. *Electronic Commerce Research*, 17(1), 83–102. <https://doi.org/10.1007/s10660-016-9245-4>

[52] We look at some of the unusual ways drones are being used | Techworld. (n.d.). Retrieved November 20, 2019, from <https://www.techworld.com/picture-gallery/apps-wearables/best-uses-of-drones-3605145/>

## APPENDIX A

### APPROVAL LETTER



Office of Research Integrity

November 22, 2019

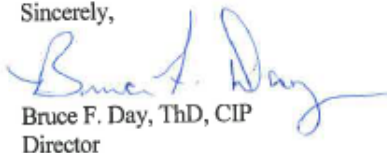
Kanimozhi Kalaichelvan  
2010 7<sup>th</sup> Ave, Apt 914  
Huntington, WV 25703

Dear Kanimozhi:

This letter is in response to the submitted thesis abstract entitled "*What People Complain About Drone Apps? A Large-Scale Empirical Study of Google Play Store Reviews.*" After assessing the abstract, it has been deemed not to be human subject research and therefore exempt from oversight of the Marshall University Institutional Review Board (IRB). The Code of Federal Regulations (45CFR46) has set forth the criteria utilized in making this determination. Since the information in this study does not involve human subjects as defined in the above referenced instruction, it is not considered human subject research. If there are any changes to the abstract you provided then you would need to resubmit that information to the Office of Research Integrity for review and a determination.

I appreciate your willingness to submit the abstract for determination. Please feel free to contact the Office of Research Integrity if you have any questions regarding future protocols that may require IRB review.

Sincerely,



Bruce F. Day, ThD, CIP  
Director

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## **APPENDIX B**

### **ACRONYMS**

**ATC** Air Traffic Control

**Bi-LSTM** Bidirectional Long short-term memory artificial recurrent neural network

**CPU** Central Processing Unit

**FAA** Federal Aviation Administration

**iOS** Apple Operating System

**IoT** Internet of Things

**NOTAMS** FAA Notice to Airmen

**OS** Operating System

**OSS** Open Source Software

**RAM** Random Access Memory

**RTH** Return to Home

**SQ** Software Quality

**UAV** Unmanned Aerial Vehicle

**UI** User Interface

**WIFI** Wireless Fidelity

**WOZ** Wizard-of-Oz technique